Marine Engineering

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Shipping Policy

THE lack of a definite shipping policy cannot be justly blamed on Congress, which over a year ago passed shipping legislation, the enforcement of the crux of which has not yet even been attempted. Congress very wisely foresaw that shipping as well as other industries required protection and that it was a case of imposing discriminatory duties or granting direct subsidies. The result has been, and also would have been even if the Shipping Board were the most efficient organization on earth, that government vessels have been allocated and chartered on terms which amount to nothing more or less than a heavy subsidy.

Most important, however, is the fact that lacking a shipping policy which would be attractive to investors in marine securities, either of the systems of bare boat charter or allocation must be placed on such attractive terms that there is always a grave danger than possible investors will consider it a better bargain to charter than to buy outright. This, of course, is contrary to the avowed intention of having our merchant marine owned and operated by private citizens and, at the same time, it is placing a subsidiary burden on the country which cannot fail to create a general opinion very detrimental to the successful development of the shipping industry.

Proposed Fees for Steamboat Inspection

ALTHOUGH the preamble of the Jones Act declares that the United States is determined to develop an adequate merchant marine, it appears that some of our congressmen must be lying awake nights devising additional burdens and obstacles to defeat this purpose. Not content with the restriction of immigration and the prevention of the sale of liquor in American vessels on the high seas, it is now proposed to saddle the expense of supporting the Steamboat Inspection Service on the merchant marine.

As an excuse for doing this it is pointed out that the Patent Office is supported by fees and also that the Steamboat Inspection Service in the early days was not only supported by such a system but was also able to accumulate a large surplus. It is further claimed that the Government ought not to render services free to one industry and at the same time charge another. But, what is the nature of the Steamboat Inspection Service? Is it not for the purpose of safeguarding life rather than property and does it not concern itself more about safe boiler pressures and lifesaving equipment than the structure of a vessel? Finally, does not the shipowner have to rely on the rules and surveys of the classification societies, which are supported by fees, in order to obtain insurance on his property?

The man who patents his own invention or the man who sends a letter should be quite willing to pay for the service rendered him, but the Steamboat Inspection Service is for the benefit of the general public and it should be classed in the same category as lighthouses, fog horns and other aids to safe navigation.

Buy Ships Now

ACCORDING to one of our English contemporaries the history of the British mercantile marine convincingly indicates that those companies which have invested largely in tonnage during a boom period have generally met with disaster resulting either in a failure or a reduction in capital. On the other hand, it has been almost invariably true that the fleets purchased during a slump have been successful. The main reason for this has been that the men who have bought in dull times knew the game and realizing that as ships must continue to sail the seas it was a good policy to purchase them when the prices were, as now, way below the cost of construction.

The best kind of a tip that now is the time to buy ships has been furnished by the example of Captain Robert Dollar who has recently purchased several vessels for his line. Captain Dollar's ability as a ship operator is universally acknowledged, in fact he is often spoken of as the dean of our shipping men, and in view of his long and successful experience it is a safe bet that he knows when to buy ships.

There can be no doubt that both Congress and the new Shipping Board now realize that the greater part of the original cost of our Government fleet must be written off as a war loss, and rightly so, for they were constructed for the defense of the nation. To saddle this burden on shipowners, if this were possible, would mean their ruin and ultimately great harm to our merchant marine, whereas the whole country will benefit if those interested in investing in shipping enterprises are given a fair chance of making good.

It is encouraging to note that Mr. Lasker's first statement indicates that the new Board will adopt the broad policy of

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considering the best interests of American shipping as a whole in liquidating the Government merchant marine rather than the possibility of making a good financial showing through the sale of vessels at war prices. With this in view prospective purchasers of vessels should make a careful study of the price they can afford to pay for tonnage with a reasonable margin for profit and this amount should be as far as possible supported by figures which if necessary can be submitted to the Board in proof of their contention.

Disarmament

WHILE there are at least thirteen reasons why an inebriate should never take a drink it is usually the case that when he gets an opportunity to indulge he is generally unable to think of one of them. This would not be so serious in itself if the results of his actions did not affect the liberties of those who possess the sense and faculty of avoiding intemperance. It is hard to sympathize with a man, who, knowing by experience the horrors, degradation and poverty that the excessive use of liquor is sure to bring upon him, still persists in drinking. His conduct, however, can be accounted for as a disease.

But what can be said of sane and supposedly intelligent people, having full knowledge of what was done to Belgium, the sinking of the *Lusitania*, the devastation of France, aye, the great suffering that still exists as a result of the inability of civilization to defend itself against a nation crazed with the lust of conquest, who can and dare to advocate making the country defenseless except for treaties which so easily become "scraps of paper?"

There are twice thirteen good reasons why this country should insure itself against a foreign soldier ever putting his foot on our soil. Let no one deny the possibility of war while such affairs as the Tulsa race riot occur in our own country. But this can only be accomplished by a powerful and efficient navy. Ships of war cannot occupy foreign countries but they can fight offensively or defensively far enough away from our shores to prevent the destruction of our seaports. Both administrations have endorsed our present naval program, but there is a disarmament string tied to it, and "lest we forget" what "pussyfooting" has accomplished in the past, it is well to watch these birds of paradise on earth for they may fly away with our battleships as they did with our schooners.

Panama Canal Tolls

IT is encouraging to note that the Senate Committee on Inter-Oceanic Canals has unanimously voted to report favorably to that body Senator Borah's bill which provides that no tolls shall be charged to vessels passing through the canal which are engaged in the coastwise trade of the United States. Although Senators Jones and Poindexter have introduced measures providing for the exemption of all American vessels from the payment of these tolls it was felt that the Borah bill had a much better chance of success as no treaty complications were involved due to the fact that only American vessels can engage in the coastwise trade.

The importance of this action at this time is particularly significant in view of the growing freight trade for our merchant marine between the Pacific and Atlantic coasts in the carriage of fruit, eggs and vegetables. A representative of the Pacific Producers' Association, which symbolizes over $300,000,000 of invested capital, and also vice-president of the California Fruit Growers' Exchange, was recently in conference with New York steamship companies to arrange for refrigerated space to carry fruit and vegetables on this route. He claimed that the consumer fixes the price and that it was the hope of the institutions that he represented that the water route would solve this problem.

The Panama Canal tolls are a direct tax on our commerce and this repeal would do much to increase the trade of the Pacific coast. As America acquired title to the land upon which the canal is constructed, paid for all the work that was done on it and is solely responsible for its maintenance, there does not seem to be any reason either in law or equity why American vessels and at least those engaged in the coastwise trade should not be exempted from the payment of tolls.

Pioneer Purchasers

THOSE American firms who were courageous and patriotic enough to purchase American tonnage from the Shipping Board at prices in the neighborhood of $200 a deadweight ton are deserving of very favorable consideration in connection with the readjustment of the sales policy to be adopted by the Government. To hold these pioneer buyers to their original contracts of $200 a deadweight ton and at the same time supply the market with ships at $50 a deadweight ton would be a very short sighted policy from a business standpoint. It would be certain to ruin or severely handicap a large percentage of a class of men upon whom America must depend to build up our merchant marine successfully and, furthermore, it would do this at a time when it is acknowledged that we have no experienced ship operators to spare.

The Government has really, if not legally, failed to live up to its part of these contracts as no action has been taken to put into force the protective features of the Merchant Marine Act which was approved June 5, 1920. In view of the exhaustive hearings and debates that preceded the passage of this Act it is not reasonable to suppose that ships were purchased whether before or after its approval without due consideration of its important features and even if they were it does not alter the fact that shipowners have not received the benefit of the protection specified in this law or anything equivalent to it.

No doubt the new Shipping Board fully realizes that close co-operation between the Government and private shipping interests can be obtained only by fair treatment. It is not fair to compel the pioneer purchasers of Government vessels to pay four times the capital interest, depreciation and insurance charges that are to be required of new buyers. If these gentlemen made a mistake in purchasing when they did, they at least showed the right spirit, and it should be remembered that those who never make mistakes never do anything. What we need in our merchant marine today is men who can do something, men who are not afraid to take the helm no matter how many mines or torpedoes lay in the channel.

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The Newly Appointed Shipping Board

Left to Right—Meyer Lissner, Los Angeles, Cal., Republican, Representing the Pacific Coast States; Rear-Admiral W. S. Benson, U.S.N., Atlanta, Ga., Democrat, Representing the Atlantic Coast States; T. V. O'Connor, Buffalo, N. Y., Republican, Representing the Great Lakes States; Albert D. Lasker, Chairman, Chicago, Ill., Republican, Representing the Interior; Hon. George E. Chamberlain, Portland, Ore., Democrat; Representing the Pacific Coast States; Frederick I. Thompson, Mobile, Ala., Democrat, Representing the Gulf States, and Edwin C. Flummer, Bath, Me., Republican, Representing the Atlantic Coast States.

Back Up the New Shipping Board

Cut Out Knocking, Get Together and Boost the American Merchant Marine

THE long expected, anxiously awaited, new Shipping Board is here at last. A little over one year from the date the Jones bill became law, seven men have been selected who will form a functioning board and it is high time for them to begin functioning at the earliest possible moment. The board, as selected, is not such as many people would desire and, like its predecessors, it is conspicuous for the absence of real shipping men. It is possibly more political that practical but, such as it is, it seems to be the best that the new executive could get together after over two months' endeavor. It is not his fault that men of the Farrell and Teagle type are not to fill these positions. They certainly were given every opportunity to serve their country in this critical time, for maritime matters.

So let us all who are interested in the American merchant marine extend a welcoming hand to the new members and resolve that henceforth we will back them up, aid them in their endeavors to keep our ships on the seven seas and make it profitable for us to do so. It is a stupendous undertaking and one worthy of our very best endeavors. Seemingly ever since the Shipping Board was first started back in 1917, it has been a source of turmoil, a butt of ill advised jokes and a target for criticism. No other branch of the Government has been so continuously in the public eye through the daily press and the torrents of ridicule, complaints and criticism have, it is quite apparent, shaken the faith of both Congress and the people in the ultimate success of our new venture on the seas after over half a century of atrophied foreign commerce. This is sincerely to be regretted, as the task of rehabilitation is in itself so herculean that there is little time to spare for anything else. Now, in addition to the tasks which would ordinarily confront the new board, it will be necessary for them to stem the tide of adverse criticism which has become so popular in Congress and in the public

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press. There is where the thorough political training of several of the new members will come in good stead.

The regular problems awaiting the earliest action of the board will require very skilful handling and the two members remaining from the old board should prove invaluable with the experience which they have already gained. In spite of the popular clamor on all sides for the Government to dispose of the fleet at once and get out of the shipping business as soon as possible, the board will soon find that such procedure is an absolute impossibility and it may as well make up its mind that the Government will have to continue to retain ownership in the greater part of its immense fleet for not only one or two years but in all probability for from five to ten years, depending largely upon how long it will take the country to return to normal business conditions. The next best thing, after the matter of retaining ownership is settled, is for the Board to determine how best the ships can be used with as little government operation as possible. It is more than probable that a liberal form of bare-boat charter will furnish the best medium for operation. Make the terms of the charter so liberal that shipping men can operate our now half idle fleet in competition with the ships of other nations and be able to make living profits in direct proportion to the skill of their management.

What is the use of talking about selling the ships to the public? When three fine ships like the *Marica,* built in 1919, get bids of only $20 per deadweight ton from the highest bidder in open competition, what would result if 10,000,000 tons of shipping should suddenly be dumped on the market? The most fortunate thing that has yet happened to our aspiring merchant marine was when the Shipping Board resolutely kept the sale price of its ships around $200 per ton, when experts were clamoring to have them put on the block at what then seemed to be the absurdly low price of $100 per ton. If the whole of the fleet, or even a goodly portion of it, had been sold to private parties at even that low price, the country today would be full of bankrupts and our merchant marine activities would have received such a setback as could not be overcome in many years. Uncle Sam is the only one strong enough to hold the bag during this world wide slump in shipping matters.

Much groaning is indulged in by members of Congress at the large deficits which the operation of the ships is rolling up. As a matter of fact, if the wage question could be settled on a basis commensurate with existing economic conditions, it is doubtful if there would be much of a deficit, despite the extremely low freight rates now being received by the vessels in operation. Slowly but surely this, the greatest single business operation on earth, has been systematized and good management has replaced to a large extent the chaotic and extravagant methods heretofore encountered in everything connected with Government operation of these ships. Most of the errors of omission and commission of the Shipping Board can now be spoken of in the past tense notwithstanding the absence of a full and functioning membership of the Board for over a year; the responsible heads of the several leading divisions have laboriously kept at their tasks and have cut out waste to a surprising extent.

The very efficient management of the construction and repair division has resulted in the removal of inefficient employees and the reduction of repair bills to a very agreeable and surprising extent. The repair bills on the Board's ships at the present time will compare very favorably with those of privately operated ships. The purchase of the vast quantities of supplies necessary for the operation of so many ships has been systematized so that now quantity purchasing is the rule, with the very gratifying result of great savings when compared to the previous haphazard purchases for individual ships or groups of ships.

It seems to be a weakness of Americans to build up some vast enterprise, gloat over our accomplishment for a brief period and then, when some minor faults are found in the structure, begin, figuratively speaking, to throw bricks at everything that has been done, investigate everything in sight and berate everybody connected with it. We have all indulged in this program with the Shipping Board and its activities until the inevitable reaction is long overdue. Let us all swear off on further criticism and each in his particular function start in to help the new Board, help the officials and help everything connected with our shipping enterprise. Give those who have stuck to their jobs and brought order out of chaos due credit for what they have done and encourage them to keep on improving. Forget the wooden ships: they have had enough anathemas already heaped upon them to sink them in the sea of oblivion, if not in the briny deep. Let some of us, somewhere, try and devise some legitimate use for these stepchildren of the Shipping Board. They are not altogether illegitimate children but they have been treated that way thus far.

The Jones bill now over a year old has not yet been given a trial. Many of us firmly believe that its provisions are ample to keep our merchant marine on the seas. Let us all get together and give it a good thorough try out, annul the conflicting treaties, put the preferential duties into operation and try out every other provision of this fine piece of legislation. If at the end of, say, two years fair and impartial trial, we find that we cannot keep our fleet on the seas in competition, then let's find out what is necessary and go get the additional legislation necessary.

We must never falter in the idea that we have got to maintain this merchant marine. As so often repeated, we are now a manufacturing nation and we must sell the twenty percent of our surplus manufactured goods or as a nation we will fall down in the struggle for existence. We cannot sell this surplus unless we have our own ships to deliver our goods to our customers direct. There must be no weakening in our efforts either, as we are playing the game with some very live and earnest seekers for the world trade.

Let me repeat again: Cut out this senseless knocking, get together and all begin boosting for what we must have—an efficient American merchant marine.

SHIPPING BOARD TO APPOINT DIRECTOR OF OPERATIONS.—The newly appointed Shipping Board is now directing its attention largely to matters of organization and personnel and is expected to announce before long the appointment of a new director of operations, who, in common with other appointees of the board, will be a man eminently qualified by training and experience to direct the work to which he is assigned. The board has issued an order that there shall be no sales of surplus materials amounting to over $1,000 without being referred to the board.

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The New Chairman of the Shipping Board

Albert D. Lasker, Executive and Organizer, Takes the Helm, Assuring a Straight Business Course for Shipping

THE new chairman of the Shipping Board does not know a ship from the keel to the main truck, but he knows business from the office boy to the president—and a business administration of our Shipping Board is of first importance. Mr. Lasker will proceed like any other executive of ability by hiring the very best men he can find as heads of the several functioning departments of the Shipping Board. In other words, besides his associates on the Board, Mr. Lasker will employ a staff of experts to carry on the actual work of building, maintaining and operating vessels until such time as the Board will undoubtedly and by gradual process turn over its ships to private interests.

Albert D. Lasker

The ultimate outcome will in all probability be that the Shipping Board will eventually confine itself to matters of policy, investigation of the relative costs, advantages and disadvantages of operating American vessels in the foreign trade as compared with vessels under foreign registry, investigating the navigation laws for the purpose of advising Congress as to what revisions are needed to develop our merchant marine and to functioning as a regulating body similar to the Interstate Commerce Commission.

Albert D. Lasker is an advertising man who is well known to publishers and business men. Ever since he went to Chicago as a boy from the Lone Star State and started his career as office boy and stenographer in the Lord & Thomas Advertising Agency he has made a success of every undertaking. His first promotion placed him in charge of the correspondence of a minor section. Next he took charge of that department and then in a short time a more important department was placed under his supervision, but right here it should be stated that while Mr. Lord recognized his exceptional ability, his capacity for hard work and his natural hustling tendencies played no small part in his success.

As his value to the firm kept increasing he was offered a junior partnership and a few years later when the original partners retired he assumed absolute control. Since Mr. Lasker became "Lord & Thomas" the business has been expanded to proportions never dreamed of by its former owners, but to relate all the achievements of the man who made "Spearmint" a household word would take more space than we have available.

The Shipping Board is one of if not the most difficult of our problems today and surely one of the most vital to the prosperity of our country. But in Mr. Lasker we have a man about 40 years of age who can and will work 16 hours a day, who makes rapid decisions and refuses to be blocked by red tape or details. He is very democratic with a pleasing personality which gives you the impression whether you know him or not that he is glad to see you. Mr. Lasker is a part owner of the Mitchell Motor Company, Van Camp Packing Company, Chicago Baseball Club and the Quaker Oats Company. He was closely identified with the Republican National Committee, during and prior to the recent presidential campaign. President Harding has spoken of him as one of the livest wires in the country and with everything to lose and little to gain; for public service rewards are never what they should be. It is certain that the new chairman will do his best to develop a merchant marine that will be a source of pride, protection and prosperity.

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A special message from Senator Wesley L. Jones, author of the Merchant Marine Act of 1920.

The George Washington

AMERICANS should travel on American ships as a patriotic duty. They should be willing to suffer some inconvenience in time and accommodations to do this. With the sailing of the **George Washington** for Europe on July 30 a new era in American shipping dawns on the Atlantic. She is a first class passenger ship of great speed. So long as she sails and has accommodations, no American will have any excuse for sailing on an alien ship. I trust she may be the forerunner of an adequate fleet of high class passenger ships crossing the Atlantic under the American flag.

Such ships maintain our commerce in peace and defend us in war. They are a striking symbol of America's greatness in every foreign port where they drop anchor. In commercial and industrial pursuits the United States stands without a peer. We have many vessels under the American flag. We are going to have a permanent, adequate American merchant marine. No minor portion of this will be constituted of passenger and combination passenger and freight liners. Vessels of the type of the **George Washington** will follow rapidly with the upbuilding of our merchant marine but we must give them support.

We can point to no greater mark of our maritime progress than the maintenance of a fleet of passenger vessels of the most efficient type furnishing regular service between the ports of the world and sailing under the American flag.

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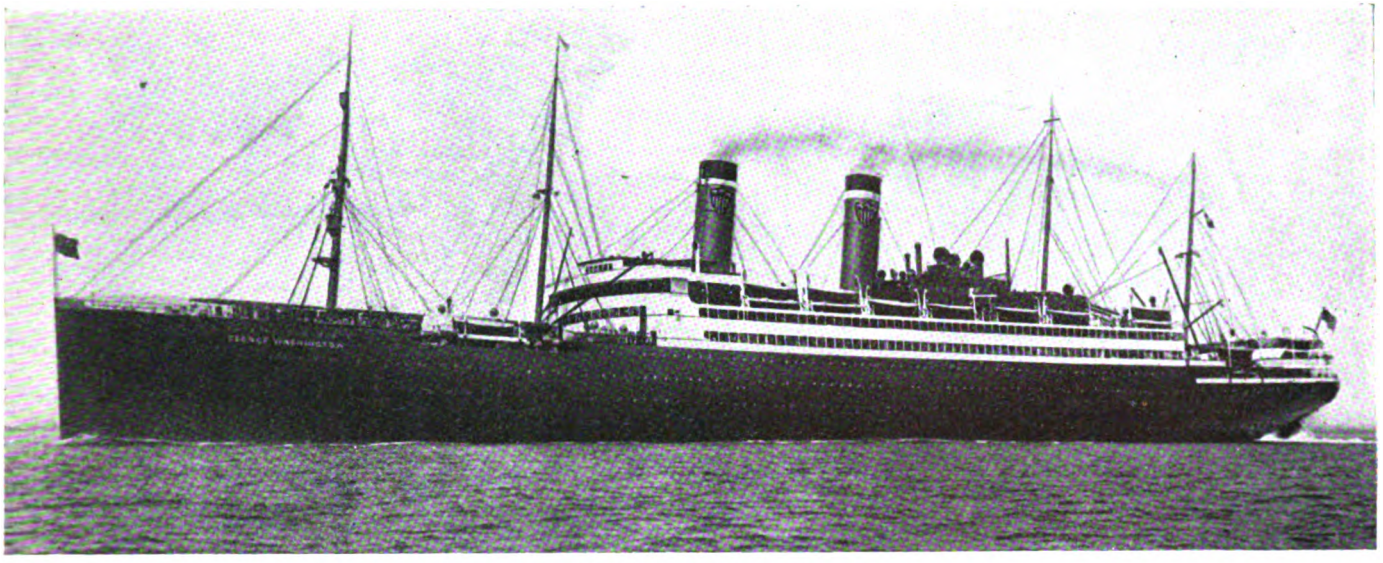

Steamship George Washington, Refitted as American Liner

American Passenger Liner George Washington

Giant Twin Screw Vessel of 25,570 Gross Tons to Be Flagship of American Fleet

By Col. George Crouse Cook*

JULY 30, 1921, will mark an important event in the annals of our merchant marine for on that day the *George Washington* will sail from New York on her first voyage under the flag of the United States Mail Steamship Company for Plymouth, Cherbourg and Bremen. They are working night and day at the Tietjen & Lang plant of the Todd Shipyards Corporation to get this big vessel thoroughly overhauled and reconditioned. Until the *Leviathan* is placed in commission, this will be the flagship of the American fleet. This job is a great accomplishment in itself, not only because every piece of equipment that is used in the reconstruction is of American origin, but also because it shows that we are capable of doing this class of work as well if not better than foreign shipyards and certainly in much quicker time.

Over a hundred thousand soldiers were transported by the *George Washington* during the war, and in addition it was used by President Wilson and his suite for both voyages to the Peace Conference at Versailles, the King and Queen of Belgium upon their visit to the United States and many other notable travelers. By virtue of these facts it has become one of the most famous passenger vessels afloat and each of its leading suites and staterooms is associated with names which are familiar not only in this country but throughout the entire world.

Commodore W. H. Bevan

The *George Washington* will be under the command of Commodore W. H. Bevan, the senior captain of the United States Mail Steamship Company's fleet, who has been a captain for fifteen years, and it will be the seventeenth vessel of which he has had command. Commodore Bevan was a lieutenant commander in the United States Naval Reserve during the war, and he was the first marine superintendent for the Shipping Board when it took over the German fleet. He not only helped put the ex-German ships into condition, but took command of one of the first vessels which carried war materials to France. This vessel had neither guns nor wireless equipment but Commodore Bevan took her across safely, although for twelve days he never took off his clothes or his shoes.

Safety Precautions

Commodore Bevan states that every known safety device will be employed on this vessel. He will have a staff captain who will always be available to take command in case of accident or sickness to him and all the senior officers are men who have commanding experience. The commodore is particularly proud of the fact that when the *George Washington* leaves America she will be fully equipped for the round trip with the exception of about 300 tons of

*Naval Architect, United States Mail Steamship Company.

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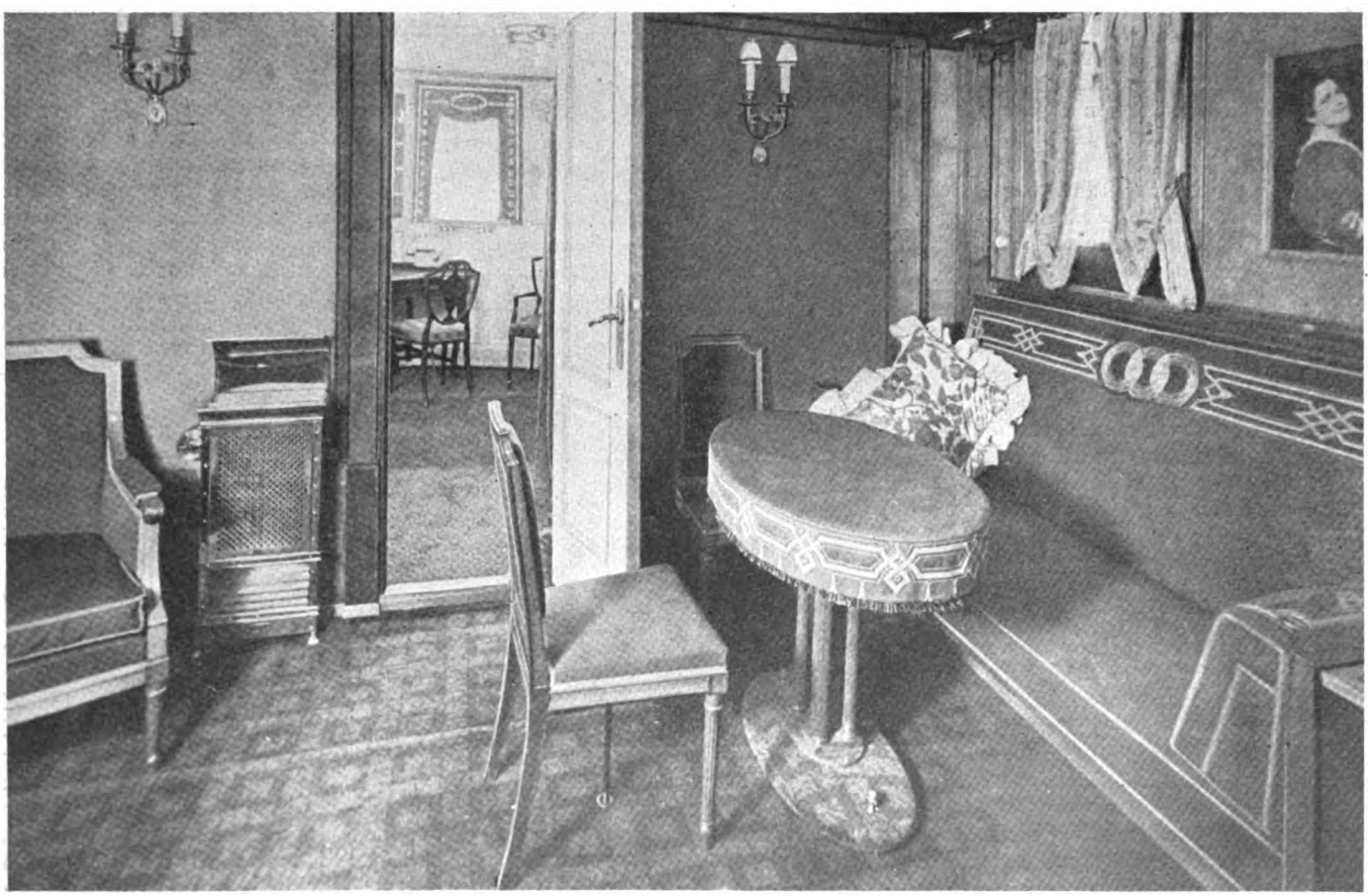

View of Suite De Luxe

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Children's Play and Dining Room

First Class Dining Saloon

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American Passenger Liner George Washington

General Information

Service: New York, Plymouth, Cherbourg and Bremen.
Builder: Vulcan, Stettin, Ger. Reconditioned by Tietjen and Lang Dry Dock Co.
Owner: U. S. Shipping Board.
Operator: U. S. Mail Steamship Co.

Characteristics

Length, overall .....722' 5½"
Length, B. P. .....700' 0"
Breadth, molded .....78' 0"
Depth, molded .....44' 9"-54' 0"
Draft loaded .....33' 0"
Draft, light .....23' 9½"
Block coefficient .....
Midship section coefficient .....
Longitudinal coefficient .....
Speed, loaded, knots.....18
Cruising radius, nautical miles 8,000
Framing .....Transverse
Class .....American Bureau A-1

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull .....
**Weight Propelling Machinery .....
Deadweight Capacity .....13,465 tons
Displacement 36,000

(In tons of 100 cubic feet)

Gross register 25,570
Net register 15,379

*Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.
**Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

Anchors: 3 Bowers .....at 18,800 lbs.
1 Stream .....at 6,600 lbs.
1 Kedge .....at 3,300 lbs.
.....
Chain: 2 Bower chains, 3½", 164 fathoms
.....
.....
.....

Rudder

Area .....
Dia. Stock .....
C. Press. abaft C. L. pintles .....

Complement

Deck Officers 15
Deck crew 109
Engineer officers 7
Engineer crew 191
Purser's and steward's department 373
Total officers and crew 695
First-class passengers 573
Second-class passengers 442
Third-class passengers 1485
Total passengers 2508
Total complement 3203

Handling Equipment

	No.	Type	Capacity	Length
Masts	4	Pole	....	....
Derrick posts	....	....	....	....
Booms	....	....	....	....
Discharging Capacity				

Deck Machinery

(Number, Size, Type)

Steering Gear .....One main steam
.....One auxiliary steam
Windlass .....
Capstans .....
Winches .....
.....

Life Saving Equipment

	No.	Capacity
Lifeboats	45	2720
Rafts	25	600

Propelling Machinery

Boilers

Number .....8 DE & 4 SE
Type .....Scotch
Length .....
Width or Diameter .....
Furnaces 60
Fuel .....Coal
Draft .....Forced
Total heating surface, square feet: 52,493.6
Total grate surface or furnace volume ....
.....1,225.52 sq. ft.
Superheat, degrees F. .....
Working pressure, lbs. per sq. in.....213
Normal fuel consumption:
Per day, tons 361
Per horsepower hour, pounds .....
Normal steam production:
Per hour per pound of fuel....lbs.
Total per hour .....lbs.

Engines

Number 2
Type .....Quadruple Expansion
Size .....38.2" x 56.7" x 79.9" x 112.2"
Horsepower 21,000

Propellers

Number 2
Type .....Built-up
Weight .....
Diameter .....21' 4"
Pitch .....24' 11¼"
R. P. M. 83
Projected area .....
Developed area .....

Auxiliary Machinery

(Number, Size, Type)

Machinery Space

Condensers .....
.....
.....
Evaporators .....One at 30 tons
Distiller .....
Filters .....
Feed water heater .....
Fuel oil heaters .....
.....
Pumps:
(6) Main feed
(3) Sanitary
(2) Ballast
(1) Fire
(3) Aux. feed
(2) Bilge
(1) Evaporator
.....
.....
.....
.....
.....

Refrigerating Machinery
Two CO_2 at 30 tons
One CO_2 at 7 tons

Electric Equipment
Generators ..Six at 110 volts, 1,000 amperes
Radio .....One at 6 KW. and one at 25 KW.
Emergency .....One

Holds

No.	Length	Hatches

Capacities

Cargo Space

Compartment	
Decks and holds	232,000 cu. ft.

Refrigerated Space

Compartment	Cu. Ft.
Stores only	517 tons

Bunkers

Compartment	Cu. Ft.	*Bbls.	*Tons
Permanent			3,913
Reserve			849
Special reserve			1,800

*....cu. ft. per ton;.....gals. per bbl.

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fresh water		2,100	
Total			

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coal and that all her stores will be purchased in our own country.

Safety has been given even greater consideration than luxuries in the equipment and outfit of the vessel. Every invention for adding to this vital element has been studied and, where practical, installed on this vessel. Among these inventions the radio compass, which was developed during the war for detecting the direction of the origin of radio signals, has been adapted in order that the bearing of such signals sent from shore stations may be definitely determined and the position of the vessel itself correspondingly located.

THE GYRO-COMPASS

The *George Washington* is equipped with one of the latest type Sperry gyro compasses. This equipment comprises the master compass and three repeater compasses, one of which is located in each wing of the bridge and one at the wheel for steering. The repeaters on the bridge are mounted in pelorus stands and take the place of the old dummy pelorus. The cards in these repeaters are kept adjusted from the master compass to the true north at all times, so that accurate and true bearings can be taken at any time regardless of the ship's head. This means more to the captain of a vessel than can be described in this limited space.

The vessel is also equipped with a recording compass, which makes a permanent record of all the movements of the ship's head and makes possible the checking up of quartermasters and any changes of course which it is desirable to record.

The more usual items of equipment, such as radio, watertight subdivision, boat equipment, etc., have been perfected in the highest degree and the radio plant, consisting of the most powerful arc light installation afloat is able to communicate with either shore from any position in the Atlantic while its maximum range under favorable conditions is approximately 7,000 miles.

Watertight doors throughout the vessel are operated by hydraulic distant control from the navigating bridge and may be instantaneously closed as a whole or individually, as may be necessary in cases of emergency.

FIRE DETECTION AND PREVENTION

The *George Washington* is equipped with one of the most complete and modern fire alarm systems available today. Saloons, card rooms, passenger and crew's quarters are all protected by the system furnished by the Aero Automatic Alarm Company. Fine copper tubing on the ceilings of these rooms are the detecting elements of this system. Their operation is unique in that it is not necessary for the heat from a fire to reach a high temperature before operating the system. All that is needed is that there be a sudden rise in temperature in the room and the air confined in this fine copper tubing will expand, actuating the diaphragms. This principle makes the system extremely sensitive and no fire, no matter how remote or small, can gain any headway without the alarm being sounded in the engine room and on the bridge. The system is absolutely automatic and ready for service at any hour of the day or night.

The holds of the vessel are equipped with the latest improved type of the Rich Smoke System. This device is an extension of the steam smothering system required by law which consists of a series of pipes leading from the boilers to all enclosed compartments and holds of the ship. This fire detecting system, by means of a small exhauster, draws air samples continuously from every compartment and hold and thus conveys the first traces of smoke to a detecting cabinet in the wheel house. The smoke is revealed in the flares of the detecting cabinet immediately and definitely locating the fire during its incipient stage.

By operating the proper valve steam, or carbon dioxide if desired, can be directed to the specific location of the fire and through the same piping. With the closing off of the steam valve the indicating line is again reestablished and detection continues unharmed by the action of the previous fire.

GENERAL ARRANGEMENT AND SCHEME OF DECORATION

All details of the modern metropolitan hotel have been introduced into the new arrangements of this remarkable vessel and owing to its great size and corresponding steadiness the traveler will find himself, when afloat, in comfort equal to that of the most luxurious home.

The general arrangement of the interior has been allowed to remain somewhat in accordance with the original layout during its operation by the Germans but the details of the decorative features throughout have been refined and modernized in conformity with the best American practice.

Specially trained joiners, cabinet workers and decorators have been brought together from all parts of the country and the quality of their workmanship proves that it is not necessary for us to go abroad to secure the most elaborate cabinet and inlay work. The very choicest of woods have been obtained from all parts of the world and there is scarcely a material used in decorative art which does not in some place find its use in the scheme of the design of this vessel. There are to be found the various classes of mahoganies, teak, satin wood, ebony, maple, walnut, etc., which are in their respective places set off by inlays of other woods, mother of pearl and metallic decorations in order to enhance the effect of the whole.

Tapestries, brocades, silks, satins, velvets, plushes, together with leather, handworked in all forms and styles, are used throughout to supplement and complete the work of the cabinet makers.

Carpets and rugs of domestic manufacture and oriental weaves have been brought together from the choicest markets of the country in order to complete the floor coverings in all public spaces and private rooms. The decks and all passageways and public spaces have also been covered with composition tilings of the highest quality and serve to brighten and finish surfaces where exposed about the margins of floor coverings and rugs.

GENERAL DESIGN

The general scheme of decoration varies with different sections of the vessel, but in general may be designated as that of a Continental character with variations and adaptations of the Colonial and Georgian periods which are drawn together to form a harmonious whole. Many of the paintings on the vessel are of American Colonial historical interest and represent scenes connected with the early days of our Republic, such as the Centennial Hall in Philadelphia, the home of Washington at Mount Vernon, various scenes about the National Capital and views of both early New York and Boston.

Bronze and marble figures and busts adorn various niches throughout and include the men and women of Colonial fame, such as Washington, Martha Washington, Franklin and others.

The lobbies about the passenger elevators leading to the grand social hall are tastefully finished in rectangular panels outlined with delicately-tinted moldings and appropriately decorated. The elevator enclosures consist of hand-wrought iron screens and the floors of the lobby within the limits of the vestibules are well tiled and laid with heavy rugs.

ACCOMMODATIONS—FIRST CLASS

Accommodations for 573 first class passengers are provided, each perfect in its appointment for convenience and comfort but varying in degrees of luxury and spaciousness. The first class accommodations are distributed through five decks and are served by electric elevators which give every comfort and convenience in reaching the various rooms and the main dining saloon.

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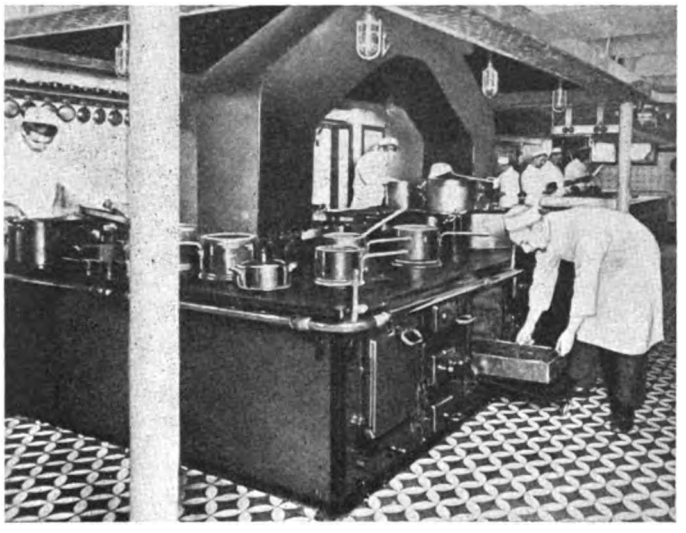
Cabin staterooms and suites are interconnected by a telephone system of the most modern approved American design and practice and the passenger may communicate throughout with the various officers, stewards, etc., without leaving his own room. The wireless telephone has also been installed and it is possible to stand upon the vessel and communicate by word of mouth with other similarly equipped vessels or shore stations at a distance of approximately 500 miles. The installation is fitted with amplifiers in order that speeches, music or other sounds may be received at their origin in a lecture hall or theatre and heard by all gathered in a dining room or other public space on the vessel.

Aft on the boat deck are the enclosed verandah-cafe, the first class upper smoking room, the radio telephone and telegraph office, the photographic dark room, newspaper office and similar spaces of general public interest.



First Class Galley

The upper promenade or *A* deck is glass enclosed throughout and assures open spaces for exercise and recreation independently of weather conditions.

READING AND WRITING ROOM

An unusually spacious and beautifully decorated reading and writing room is situated on the *A* deck well forward, and offers an unobstructed view ahead and to port and starboard. In addition to its permanent loan collection of the finest literature, it contains a magazine and book store and the offices of the public stenographer.

The reading and writing room is finished in natural satinwood, inlaid with ebony and mother of pearl, developed along the lines of the Continental style. The cabinet work about the room consisting of writing desks, book cases, cabinets, settees, etc., are executed with extreme skill and certain doors are decorated with elaborate hand-wrought wood and metal grilles and screens to harmonize with the whole. The portable furniture and tables are constructed and upholstered to correspond and complete the room in a most exquisite style.

GRAND SOCIAL HALL

The grand social hall, which is the largest individual public room on the vessel, is located on the *A* deck right aft of the reading room and consists of a main central portion and four anterooms or bays. The central portion of the floor is covered by a large hardwood dancing area which, when not being used, is covered by heavy rugs. This room is finished in shades of felted French gray and decorated with a series of paintings of Colonial American interest including a well known portrait of George Washington which is mounted over a Colonial fireplace of exceptionally artistic design.

The skylight, which covers the entire central area of the room, is of heavy leaded glass in simple and appropriate artistic design illuminated by numerous electric lights providing for an indirect system of illumination.

The fireplace and mantel at the head of the room are exceptionally complete and correct examples of the Georgian period.

A grand piano, settees, party and individual tables, social and winged arm chairs upholstered in tapestry and brocades are placed about the room and form a convenient and attractive setting.

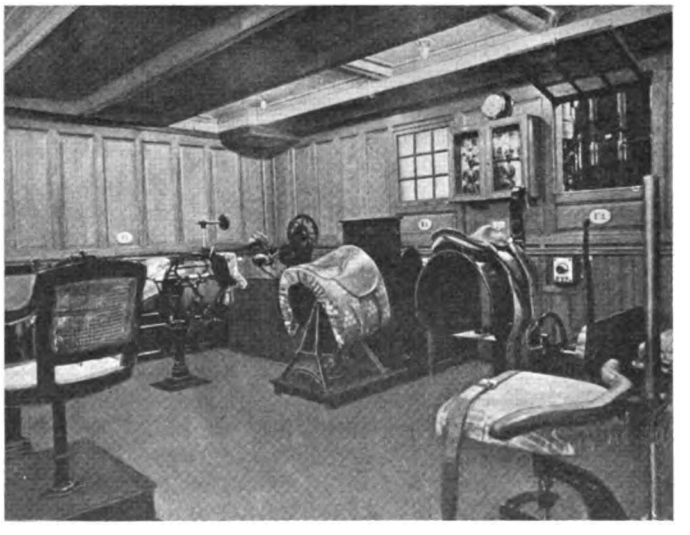
Each of the four anterooms, which are separated from the main area of the hall by panel work and heavy brocade hangings, is developed in an individual style in natural mahogany, walnut, etc., and the walls finished with silk panels matching the natural woodwork. Suitable tables, settees, and chairs are furnished and the spaces form as charming nooks for card parties, luncheon or tea service as may be desired

At the aft end of the grand social hall is a monumental stairway which is finished in felted grays to match the colors of the room and which leads directly to the foyers of the de luxe suites on the deck below. It is ornamented in a simple style of panel work and mirrors and a clock on the electric time system of the vessel.

FIRST CLASS LOWER SMOKING ROOM

The lower smoking room which terminates the first class passenger accommodations on *A* deck is finished in natural walnut inlayed with ebony.

The walls of this room, above the line of settees, are decorated in embossed, hand worked leather in rich brown tones and a marble mantel above an electric fireplace at the after end of the room is surmounted by panes of plate glass mirror enclosed in metal frames.



Gymnasium

Heavily upholstered, fixed settees and arm chairs finished in blue leather, together with individual and party tables are placed about the room for the comfort and convenience of its occupants. A counter for the sale of cigars, cigarettes, etc., is located at the forward starboard corner of the room.

B DECK

The *B* deck is given over chiefly to first class accommodations consisting of rooms with individual baths and de luxe suites.

There are four de luxe suites of particular elaborateness, two of which were occupied by President and Mrs. Wilson

(*Continued on page* 561)

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Another Burden for Shipowners Proposed

Congress Considering the Revival of a Fee Basis to Make the Steamboat Inspection Service Self-Supporting

By Waldon Fawcett

FROM the very nature of things, the United States Department of Commerce must have intimate contact with the shipping and shipbuilding interests of the nation. Within this complex organization are many of the governmental institutions that deal constructively with maritime affairs—the Bureau of Navigation, the Steamboat Inspection Service, the Coast and Geodetic Survey, the Bureau of Fisheries and the Bureau of Lighthouses. Concentrated in this quarter also are institutions the activities of which indirectly, if not directly, have considerable influence upon American maritime progress. For example, there may be cited the Bureau of Foreign and Domestic Commerce and the Bureau of Standards, not forgetting the manufacturers' census of the Census Bureau.

That this executive organization which, as it stands, corresponds substantially to the departments of maritime affairs of foreign governments, should have entered in 1921 upon what promises to be its era of greatest usefulness is to be ascribed to the advent of Herbert Hoover as Secretary of Commerce. Mr. Hoover is not a practical shipping man. He is, however, a man of large affairs who, during a varied career, has been forced to take at all times the international outlook and whose deductions have been those of the trained and experienced engineer. More than that, Mr. Hoover had, during the world war and since, an intimate contact with the larger problems of oceanic transportation, handling and storage conditions at leading ports, etc., that afforded the most valuable prelude possible for his present responsibilities.

Inadequate Appropriations

With characteristic energy and by muster of unusual influence Secretary Hoover will probably accomplish in his new post that, the lack of which has been most largely responsible for the agitation for the ocnversion of the commerce department into a maritime department. Lack of adequate operating funds has been, as many shipping men doubtless realize, a serious impediment to the progress of the Department of Commerce for a number of years past. Certain branches of the Department were, to be sure, liberally provided for during the war, when their work was necessary for the success of military and naval operations. But the Commerce Department as a whole, and particularly the divisions devoted to maritime activities, has been so skimped in allowances that it has been with difficulty that routine work has been sustained, much less entry made upon the new projects that are essential to keep step with the progress of the period.

Just where the blame has rested may not readily be determined. Congress has been prone, obviously, to pare the appropriations for all governmental undertakings that have not the virtue of insistence. And the Department of Commerce has lacked a Moses to preach, on Capitol Hill, the gospel of the essentiality of its work. This is precisely what Secretary Hoover has set out to do. By personal appearance before the Appropriations Committees of Congress, by public addresses and by arousing the conscience of trade organizations and commercial bodies, the new Secretary of Commerce is endeavoring to induce the national legislature to provide funds that will enable his Department to supply something more than moral support to American shipping in the era of quickened international competition that impends.

Perhaps the most graphic illustration of the deficiencies of maritime service which Secretary Hoover has set out to correct is afforded by the radio situation. The enforcement of the wireless communications laws falls to the Bureau of Navigation but the funds provided for the task in recent years have been hopelessly insufficient. According to the frank confession of officials of the Navigation Bureau, the competent members of the personnel are leaving and the service is breaking down. During the past year 15 out of a total force of 27 have resigned. But the executives have faced the fact that, regardless of whether disaster happens from incomplete inspection, they could not exceed the money limitations set by Congress.

Radio Law Enforcement

The deplorable consequence of the short allowance, regarding which Secretary Hoover has entered protest, is that there are numerous requirements, and important requirements, in the wireless communications laws that the government does not even attempt to enforce. For instance, the Bureau of Navigation has practically abandoned the inspection of ship and shore stations for license. This leaves the Bureau practically without any information as to those stations, the wave lengths they are using, or the extent to which they may be interfering with the commercial wireless and with the receipt of distress messages from vessels at sea. There are about 3,000 ship stations and of that number 2,000 yet remain uninspected for license although the international convention specifically requires that every ship station shall be licensed by the nation to which the vessel belongs. Great Britain at present is beginning to inform American vessel masters that unless their stations are licensed they will be penalized when they enter British ports.

According to the information in the possession of the Bureau of Navigation at the close of May, 1921, about 50 percent of American vessels equipped with wireless are clearing without inspection. The Bureau officials are perturbed, feeling that the inspection of the instruments on these vessels is exceedingly important for the reason that the instruments are very delicate and are readily thrown out of adjustment, whereas the operators on board are not deemed to be, in most instances, competent to make repairs or adjustments. Within the expectations of the officials at Washington, the wireless men on the ships are operators, pure and simple, receiving and sending messages, but not radio engineers. Even if the ship man qualifies as a radio engineer, he has not at hand, presumably, the instruments with which to make adjustments.

Unable to Send Distress Signal

How serious for shipping interests this situation is and how well it has justified a personal appeal to Congress by Secretary Hoover was indicated only a short time ago when an inspector, on the staff of the Bureau of Navigation, found that the instruments on board a vessel, when adjusted to the 600-meter wave length on which distress calls are sent would not send out a distress signal—did not send a sound. This was but one of a number of similar instances. Equally

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serious from the shipping standpoint is the fact that with the increasing use of the radio for point to point communication on land, systems are being created throughout the country that are resulting in a degree of interference with the ship stations—the lifesaving mediums of the ships.

FEE BASIS FOR INSPECTION

The collapse of the government's wireless inspection service, because the expense of the system has grown out of the bounds of the $60,000 a year that has been allotted by Congress, has lately precipitated the question whether it might not be wise to make a charge to shipowners or operators for the inspection and license service, as is done by some other maritime countries. In answer to questions on the subject by leading Congressmen, Secretary Hoover has stated that he does not see any great objection to thus making the service partially or wholly self-supporting, similar to the United States patent system, etc. Great Britain makes a charge of 5 shillings for a ship station license and the same fee for a ship operator's license. Canada charges a $10 fee for a limited coast station or private commercial station and $1 for a ship station. In Spain the proprietor or licensee must pay all the expenses incurred by the official inspection by the government inspectors.

More significant to shipping men than this narrow proposal that the United States Government place its wireless inspection service on a fee basis is the broad proposition that is quietly receiving consideration in influential circles in Congress whereby the entire maritime inspection system would go back on a fee basis. The plan, should it be adopted, would be resorted to as a means of rendering prompt and efficient the supervisory and license services of the Department of Commerce without involving the Government in the additional expense which many of the legislators feel that it cannot sustain in the present state of the public finances.

STEAMBOAT INSPECTION SERVICE

This suggestion that the burden of expense involved in inspections be transferred from the shoulders of Uncle Sam to those of shipowners and operators was broached, even before the discussion over wireless inspections, in the course of deliberations at the Capitol with reference to the United States Steamboat Inspection Service—likewise a responsibility of the Department of Commerce. In conversation with a group of Congressional leaders, George Uhler, supervising inspector general, had stated that, beginning in 1922, a supplemental appropriation of $25,000 a year would be needed to cover the increase in the volume of inspection work, due to the expansion of the merchant marine and other causes. Thereupon, Congressman Joseph G. Cannon asked the head of the Steamboat-Inspection Service whether the laws could not be amended in such a way that the expense would be placed upon the vessel owners who presumably benefit by the inspection.

General Uhler stated that this could, of course, be done, if Congress was so minded, and he intimated that he thought it would be an excellent plan and entirely equitable and consistent, since, as he expressed it, "Great Britain charges for their surveys and charges for their commissions, or licenses as they call them, to officers." The increase in the traveling expenses of United States inspectors, coming on top of sharp increases in the rentals of offices at various ports occupied by the inspection service, has brought an addition in overhead which may reasonably be expected to continue for some time and which must be met by some other means than recurring "deficiency" appropriations by Congress.

The feeling in Congress is that if the fee system is invoked for services to vessels, all governmental services in the category should go on a pay basis, since it would not be equitable to single out the wireless or the steamboat inspection service for toll taking and allow other activities to be conducted wholly at government expense. The discussion has also brought out the fact that it is the general policy of maritime nations to impose fees for services rendered, such as the measurement of tonnage of ships, issue of registers, approval of crew lists and, as has been pointed out, for licenses for wireless ship stations and operators. These various fees take, in the administration of various maritime powers, the form of a stamp tax.

FEES FORMERLY COLLECTED

While the circumstance has, doubtless, escaped the memory of many shipping men, the fact remains that the United States, for many years following the inauguration of its principal shipping inspection services, followed the conventional plan of collecting fees proportionate to the services rendered. However, in the year 1886 the Congress of the United States, by a rather radical action, abolished practically all the fees that had up to that time been exacted for services to American ships. At that time, the revenues of this country exceeded its expenses and Congress was concerned over the possibility of a surplus rather than a deficit in the Treasury. Indeed, the fee system in the case of the Steamboat Inspection Service, instead of merely meeting expenses or making the service self-sustaining,had piled up a surplus of $600,000 to $700,000 to the credit of the Steamboat Inspection Service, even as the United States Patent Office has a heavy surplus to its credit in the United States Treasury, thanks to the collection of fees from inventors and registrants of trademarks.

That many shipping men will resent the imposition of fees may be expected, the more surely, when it is recalled that when the fee system was abolished in 1886 a number of vessel owners felt so deeply on the subject that, not content to be relieved of further charges of that kind, they sought to recover from the government the fees or license charges that had been paid during the years before the law was repealed. The financial managers of Congress at that time would not hear of the return of any fees, declaring that such a precedent would open the way for claims against every surplus in the national treasury. But some of the shipping men were never satisfied that they were not discriminated against in favor of competitors who came into the business after the fee system went to the discard.

SELF-SUPPORTING BASIS

The general proposal to put all United States maritime inspection services back on a fee basis is induced, of course, by the fact that the government is now staggering under a heavy burden of debt and seeks to reduce its fixed charges instead of increasing them. Asked specifically as to Steamboat Inspection Service by interested Congressmen, Secretary of Commerce Hoover said: "I think there is a good deal to be said regarding putting this service back on a fee basis. It does seem to me that when a special service is given one particular industry like this, the service ought to carry its own expense. If Congress wishes to give financial assistance to that industry, it should be given directly and not indirectly."

Secretary Hoover and his subordinates have told Congressional committees that the maritime inspection services can be put on a self-supporting basis without much difficulty, but it is admitted that careful calculation would be needed to fix the proper schedules of fees. For Secretary Hoover feels that the fees should be gaged merely to meet expenses and not to return any profit to the Government as was done

(*Concluded on page* 560)

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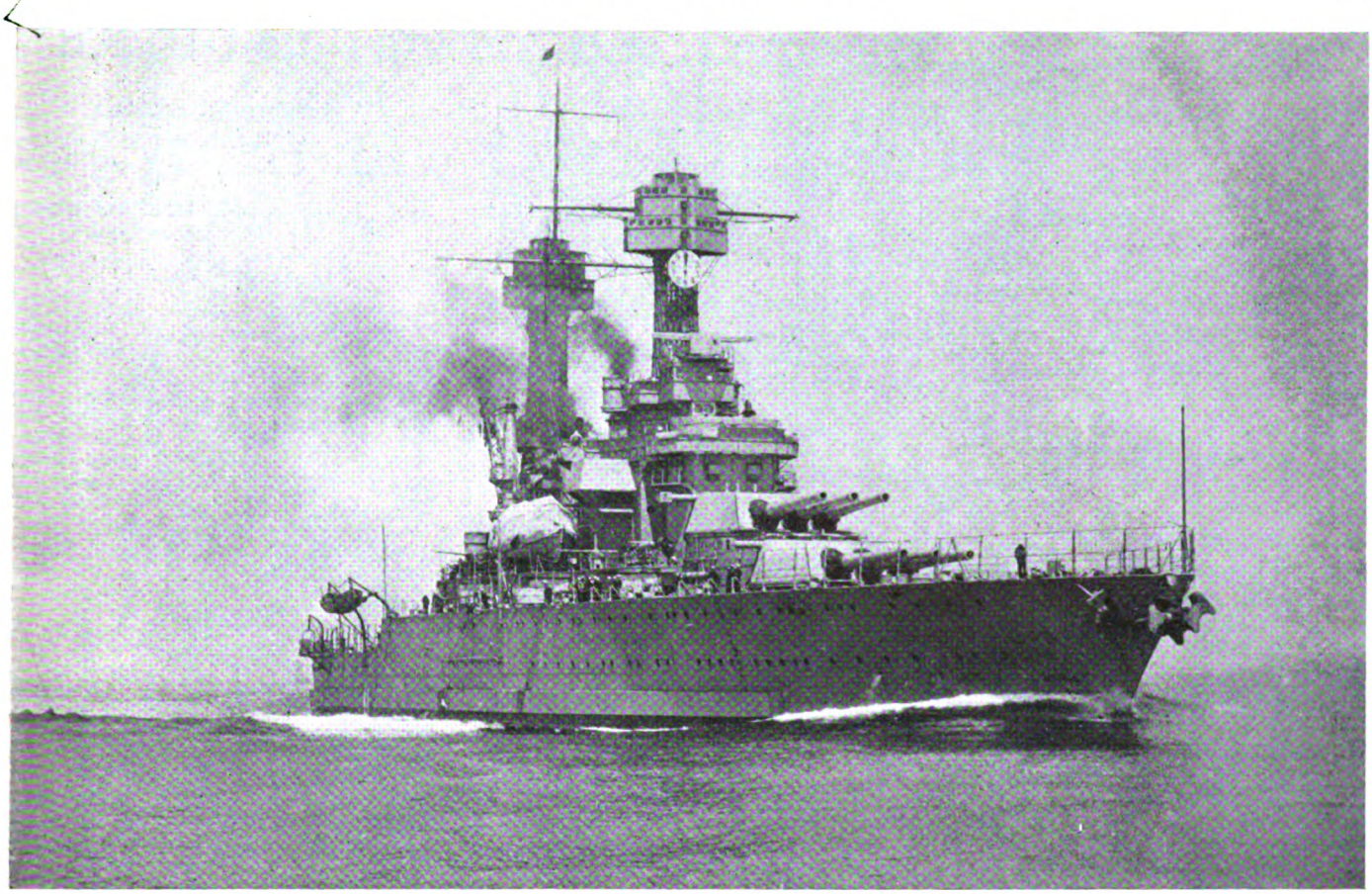

U. S. S. Tennessee at Full Speed on Her Trials Off Rockland, Me., May 16

Battleship Tennessee Successfully Completes her Final Trials

THE United States battleship *Tennessee,* the latest electrically-propelled superdreadnought, was given her final trials off Rockland during the latter part of May and among the results the following are of special interest:

Her actual steam consumptions at various speeds were better than the Westinghouse Company's guarantees by from five to ten percent.

The maximum speed developed was 21.378 knots.

She was brought to rest from top speed in less than three minutes. This is believed to be a record for so large a ship and is about the severest test that can be imposed upon her machinery, as the propellers were being operated astern while the ship was forging ahead.

The salvo test, i. e., the firing of all twelve 14-inch guns at once, caused no injury to her electrical equipment.

With astern operation of her propellers she developed 15 knots.

Her turning circle with all propellers operating forward and rudder hard-over is about 700 yards, which is hardly more than that of a destroyer.

The propelling machinery of the *Tennessee* consists of two 15,000-KVA Westinghouse turbo-generators and four 8,375 horsepower Westinghouse propeller motors. Her length is 625 feet, beam 91 feet and displacement 33,000 tons.

9,420-Ton Tankers San Lamberto and San Leon

THE following description, drawings and details of these vessels should be of special interest on account of the completeness of the data furnished. It is the practice of MARINE ENGINEERING to present data of modern vessels of various types in such form as to make it suitable for ready reference.

The *San Lamberto* and *San Leon* are vessels of the shelter deck type constructed on the Isherwood system of longitudinal framing and classed 100A-1 Lloyd's. They also comply with the requirements of the Panama and Suez Canal authorities and the rules and regulations of the United States Steamboat Inspection Service and also the regulations of the British Board of Trade.

The vessels were built by the George A. Fuller Company at their shipyard in Wilmington, N. C., a feature of the work being the speed in construction accomplished, the contract being signed August 31, 1920, and the vessels delivered February 19 and March 29, 1921, respectively.

The *San Lamberto* and *San Leon* are equipped with the White System fuel oil burning installation, Reilly evaporator and feed water heater, Schutte & Koerting injector and Hall refrigerating machine.

Lito-silo decking is provided throughout the living spaces except in toilets, bath rooms and galley, where tile or cement is used.

These vessels completed the outstanding contracts of the Fuller Company and upon their delivery the yard was closed. The surplus material and plant of the Wilmington yard will be offered for sale and another of the large companies, which responded to the call of the Government to help meet the demand for ships in the war emergency, will retire from shipbuilding.

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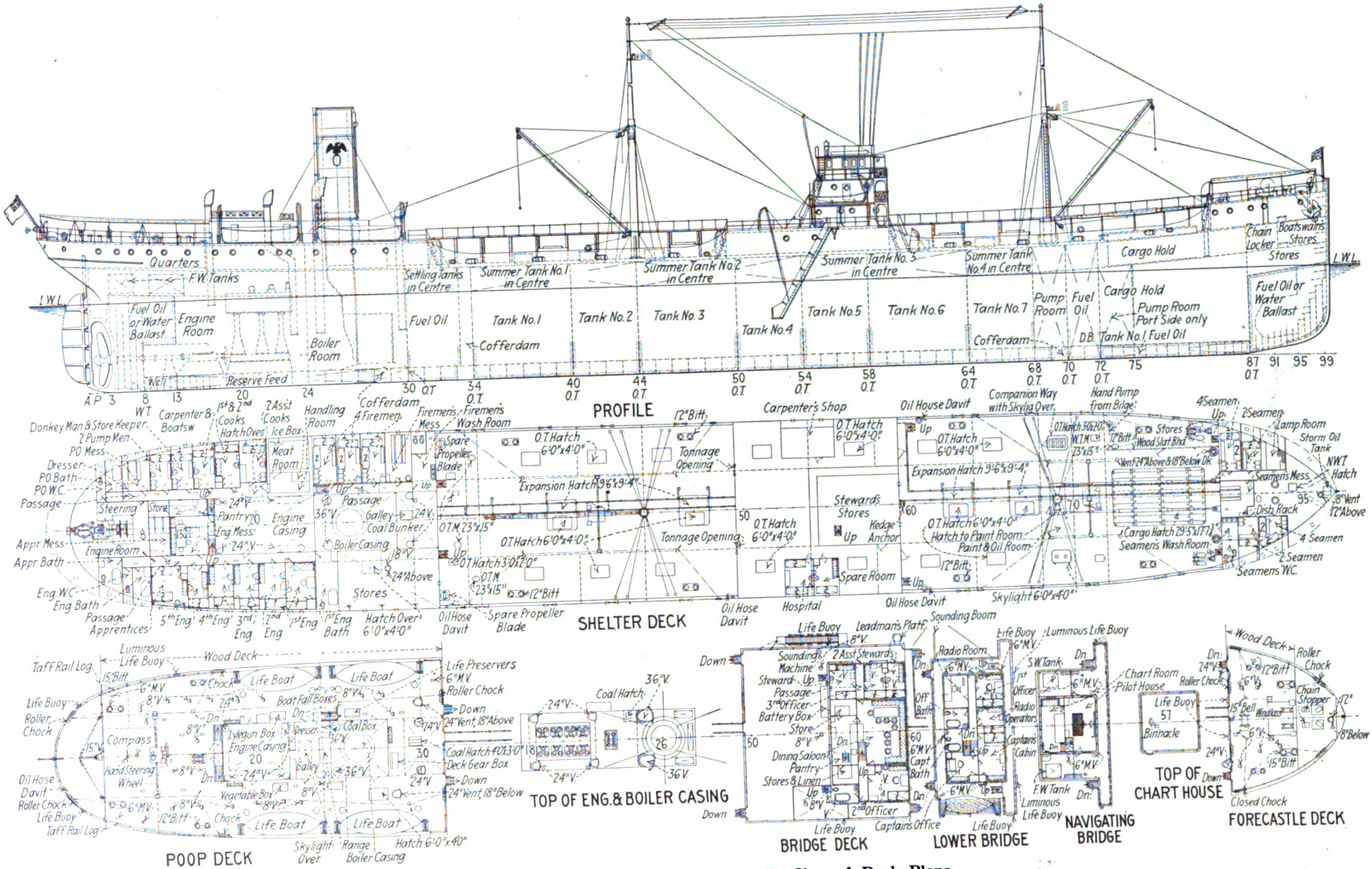

Fig. 1.—9,420 Deadweight Ton Tanker: Profile and Deck Plans

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9,420-Ton Tankers San Lamberto and San Leon

General Information

Service: Bulk Petroleum Tanker.
Builder: George A. Fuller Co., Wilmington, N. C.
Owner: Eagle Oil Transport Co., Ltd., London, England.

Characteristics

Length, overall	411′ 9″
Length, B. P.	395′ 6″
Breadth, molded	55′ 0″
Depth, molded, to shelter deck	34′ 11″
Draft, loaded	27′ 4¼″
Draft, light	9′ 3″
Block coefficient	0.78
Midship section coefficient	0.978
Longitudinal coefficient	0.873
Speed. loaded, knots, designed	10.5
Cruising radius, nautical miles	
Framing	Longitudinal
Class	Lloyd's 100 A-1

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull	3,411
**Weight Propelling Machinery	510
Deadweight Capacity	9,420
Displacement	13,341

(In tons of 100 cubic feet)

Gross register	6,349
Net register	3,808

* Weight of Hull includes Hull Proper, Hull Fittings, Equipment and Outfit.

** Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez	6,671	4,674
Panama	6,740	6,019

Equipment

2 Bower Anchors, stockless, each,	63¾ cwts.
1 " " " "	54½ "
1 Stream " ex.-stock, "	17½ "
1 Kedge " " "	7½ "
Cable, 2¼″, stud chain	270 fms.
Streamline, 4¼″ steel wire	90 "
Towline, 4½″ steel wire	120 "
Hawsers, 2, 8″ Manila, each	90 "
Warps, 2, 8″ Manila, each	90 "

Rudder

Area	169 sq. ft.
Dia. Stock	11″
C. Press. abaft. C. L. pintles	3′ 8½″

Complement

Deck officers and wireless operators	6
Deck crew	10
Engineer officers	5
Engineer crew	13
Purser's and steward's department	15
Total officers and crew	49
First-class passengers	None
Second-class passengers	None
Third-class passengers	None
Total passengers	
Total complement	49

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	steel	....	....
Derrick posts	....	....	....	....
Booms	3	steel	5 ton	....
Discharging Capacity				

Deck Machinery

Steering Gear	right and left screw
Type	double 9″ x 9″ engine
Windlass	steam, double 9″ x 9″ engine
Capstans	
Winches	(1) 9″ x 9″ double geared (2) 8¼ x 8 single geared

Life Saving Equipment

	No.	Type	Length
Lifeboats	2	metallic	24′-0″
"	2	"	26′-0″

Propelling Machinery

Boilers

Number	3
Type	single ended Scotch
Length	11′-3″
Diameter	15′-3″
Furnaces	9
Fuel	oil
Draft	forced (closed ash pit)
Total heating surface, square feet	9411
Total grate surface or furnace volume	210 sq. ft.
Superheat, degrees F.	
Working pressure, lbs. per sq. in.	200
Normal fuel consumption:	
Per day, tons	
Per horsepower hour, pounds	
Normal steam production:	
Per hour per pound of fuel	lbs.
Total per hour	lbs.

Engines

Number	1
Type	triple expansion reciprocating
Size	24½″ x 41½″ x 72″ x 48″ stroke
Horsepower, designed	2,800

Propellers

Number	1
Type	built up, 4 bladed
Weight	
Diameter	17′-0″
Pitch	15′-9″
R. P. M.	80
Projected area, sq. ft.	76.73
Developed area, sq. ft.	88.30

Auxiliary Machinery

Machinery Space

Condensers, main, 3,500 sq. ft. cooling surface
aux., 600 sq. ft. cooling surface

Evaporators	(1) capacity, 25 tons per day
Distiller	
Filter	capacity 600 gallons
Feed water heater	45,000 lbs. per hour
Injector (L)	
Forced draft fan	75″ (2) 7 x 5 engines

Pumps

Main circulating	centrifugal 14″
Feed	(2) vert. simplex 12 x 8 x 18
Ballast	(1) horiz. duplex 12 x 10¾ x 12
Sanitary	(1) 6 x 5¾ x 6
Fresh Water	(1) 6 x 5¾ x 6
Fuel oil transfer	(1) 7½ x 6 x 10
Aux. air and circulating	10 x 12 x 12 x 12
†Air	26 x 21
†Bilge	(2) 5 x 21
†Evaporator feed	1¾ x 8
Cargo oil pumps	(2) 18 x 14 x 24
Fuel oil service	(2) 6 x 4 x6
Donkey and fire	(1) 12 x 10¼ x 12

† Worked from a walking beam on the low-pressure cylinder.

Refrigerating Machinery

1 Unit—Hall's	CO_2—2-ton

Electric Equipment

Generators	(2) 15 K.W.—100 volts—D.C.
Radio	Marconi
Emergency	

Holds

No.	Length	Hatches
1	47′-3″	29′-5″ x 17′-7¾″

Capacities

Cargo Space

Compartment	Cu. ft.	Bbls.	Tons*
No. 1 main tank, P. & S.	53,794	9,581	1,345
" 2 " " "	35,910	6,395	898
" 3 " " "	53,794	9,581	1,345
" 4 " " "	35,910	6,395	898
" 5 " " "	35,910	6,395	898
" 6 " " "	53,794	9,581	1,345
" 7 " " "	37,896	6,749	947
" 1 summer tank	11,455	2,040	286
" 2 " "	11,455	2,040	286
" 3 " "	11,455	2,040	286
" 4 " "	4,764	848	119
Totals	346,137	61,645	8,653

	Cu. Ft. Bulk	Cu. Ft. Bales
For'd cargo hold	60,990	56,100

* 40 cu. ft. per ton.

Refrigerated Space

Compartment	Cu. Ft.
Provision room	550

Bunkers

Compartment	Cu. Ft.	*Bbls.	*Tons
Aft. P. & S.	28,392	5,056	747
Forward, P. & S.	19,824	3,531	522
Double bottom for'd, P. & S.	3,690	657	97
Settling tanks	3,654	651	96
Fore. peak	6,776	1,207	178
Totals	62,336	11,102	1,640

*38 cu. ft. per ton; 42 gals. per bbl.

Tanks

Compartment	Cu. Ft.	Tons F.W.	Tons S.W.
Fore peak	6,776	194	199
Aft peak	4,977	138	142
Double bottom, forward	3,690	102	105
Total	15,443	434	446

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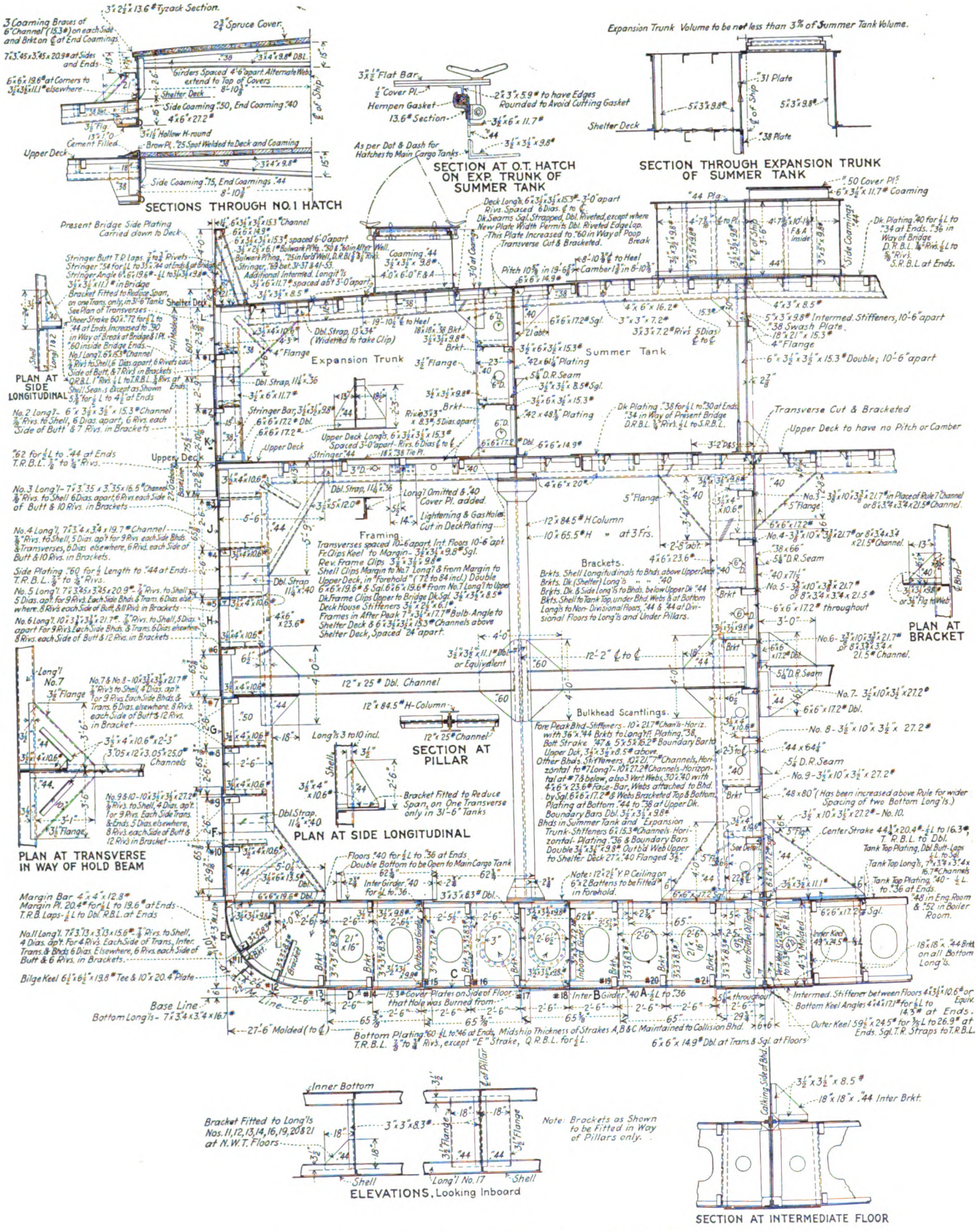
SECTIONS THROUGH NO.1 HATCH
SECTION AT O.T. HATCH ON EXP. TRUNK OF SUMMER TANK
SECTION THROUGH EXPANSION TRUNK OF SUMMER TANK
PLAN AT SIDE LONGITUDINAL
PLAN AT TRANSVERSE IN WAY OF HOLD BEAM
PLAN AT SIDE LONGITUDINAL
SECTION AT PILLAR
PLAN AT BRACKET
ELEVATIONS, Looking Inboard
SECTION AT INTERMEDIATE FLOOR
Framing.
Brackets.
Bulkhead Scantlings.
Expansion Trunk
Summer Tank
Upper Deck
Shelter Deck
Base Line
Bottom Plating
Transverse Cut & Bracketed
Upper Deck to have no Pitch or Camber
Expansion Trunk Volume to be not less than 3% of Summer Tank Volume.

Fig. 2.—9,420 Deadweight Ton Tanker: Midship Section

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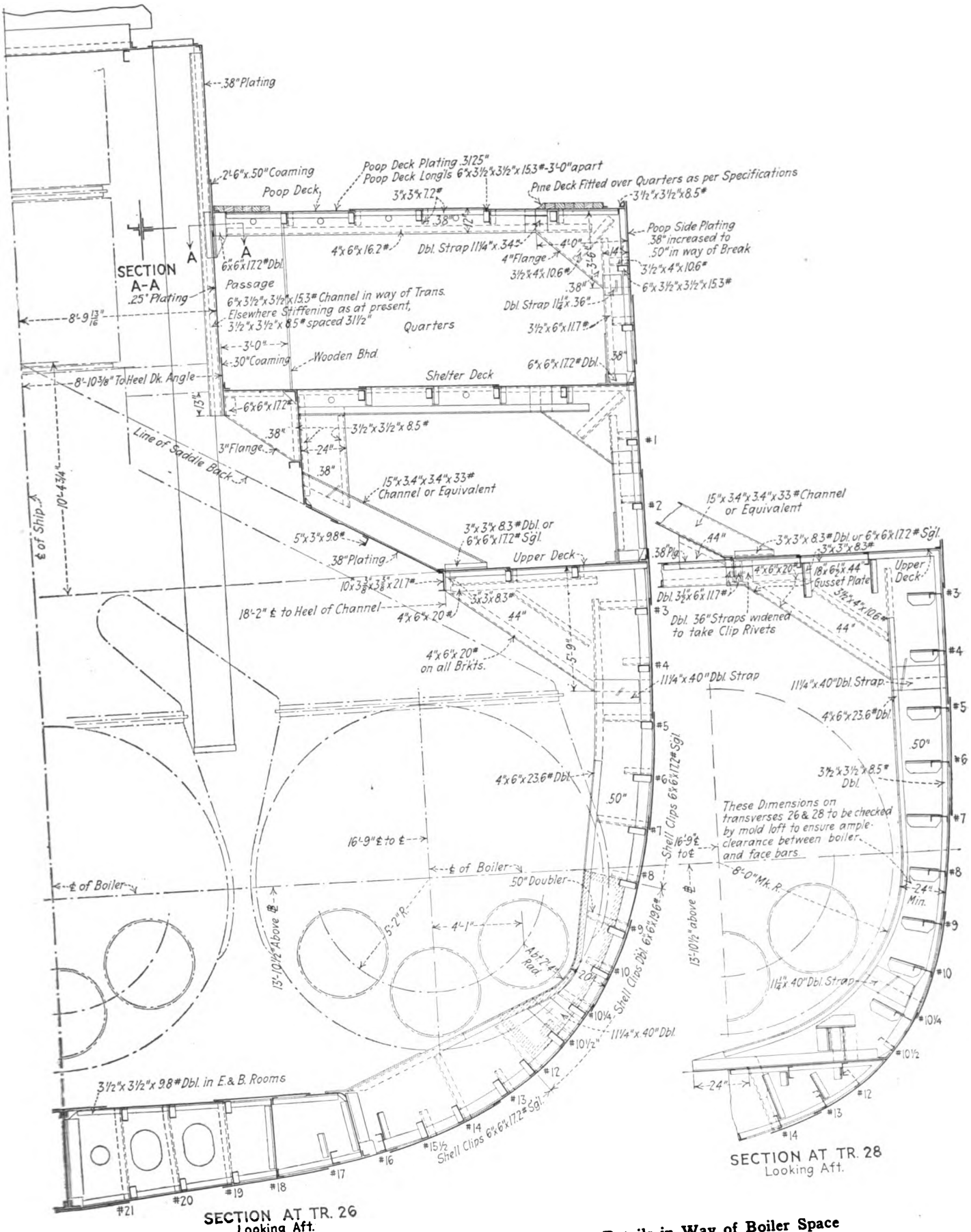

Fig. 3.—9,420 Deadweight Ton Tanker: Framing Details in Way of Boiler Space

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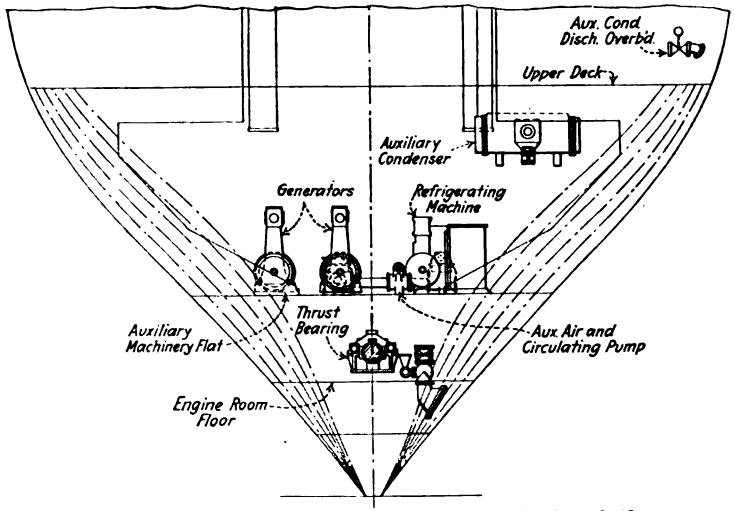
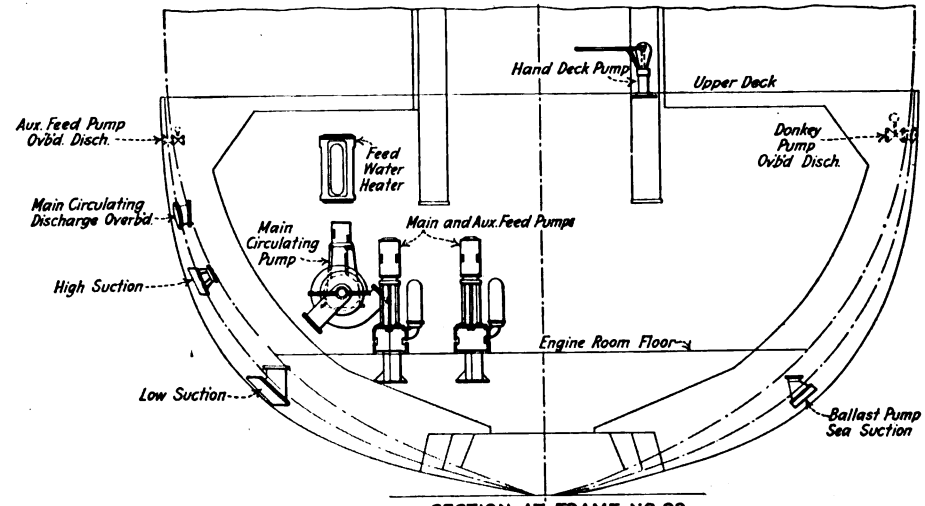
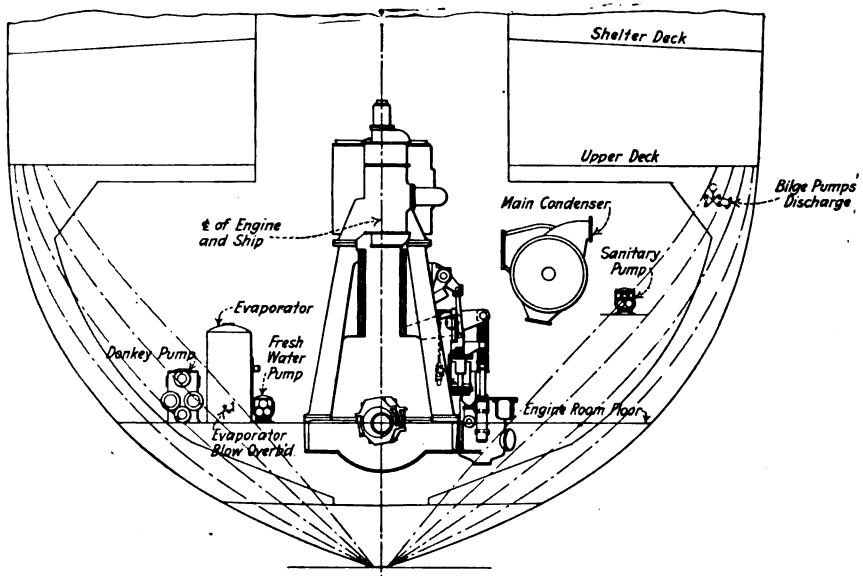


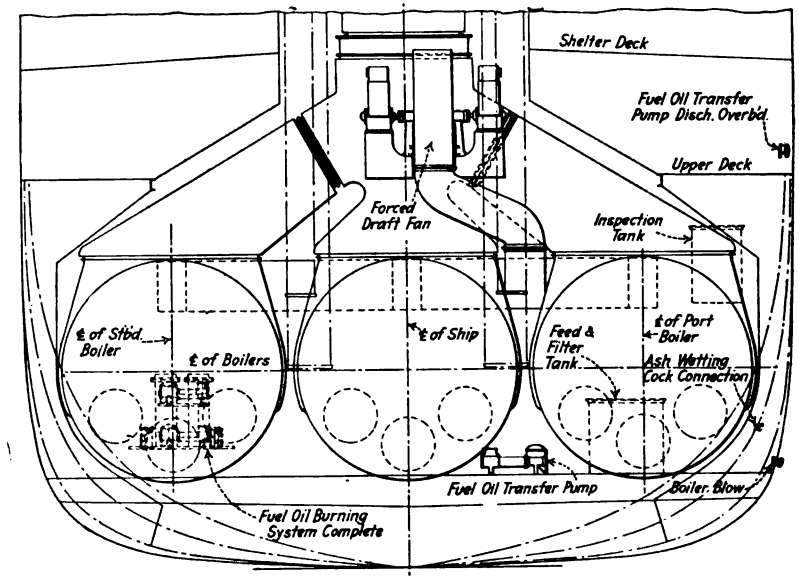
SECTION OF ENGINE ROOM AT FRAME NO. 18
Looking Aft. to Bhd. No. 13



SECTION AT FRAME NO. 22
Looking Ford to Bhd. No. 24



SECTION OF ENGINE ROOM AT FRAME NO. 22
Looking Aft to Frame No. 18



SECTION OF FIRE ROOM AT FRAME NO. 29
Looking Aft to Bhd. No. 24

Fig. 4.—9,420 Deadweight Ton Tanker: Machinery Arrangement, Sections

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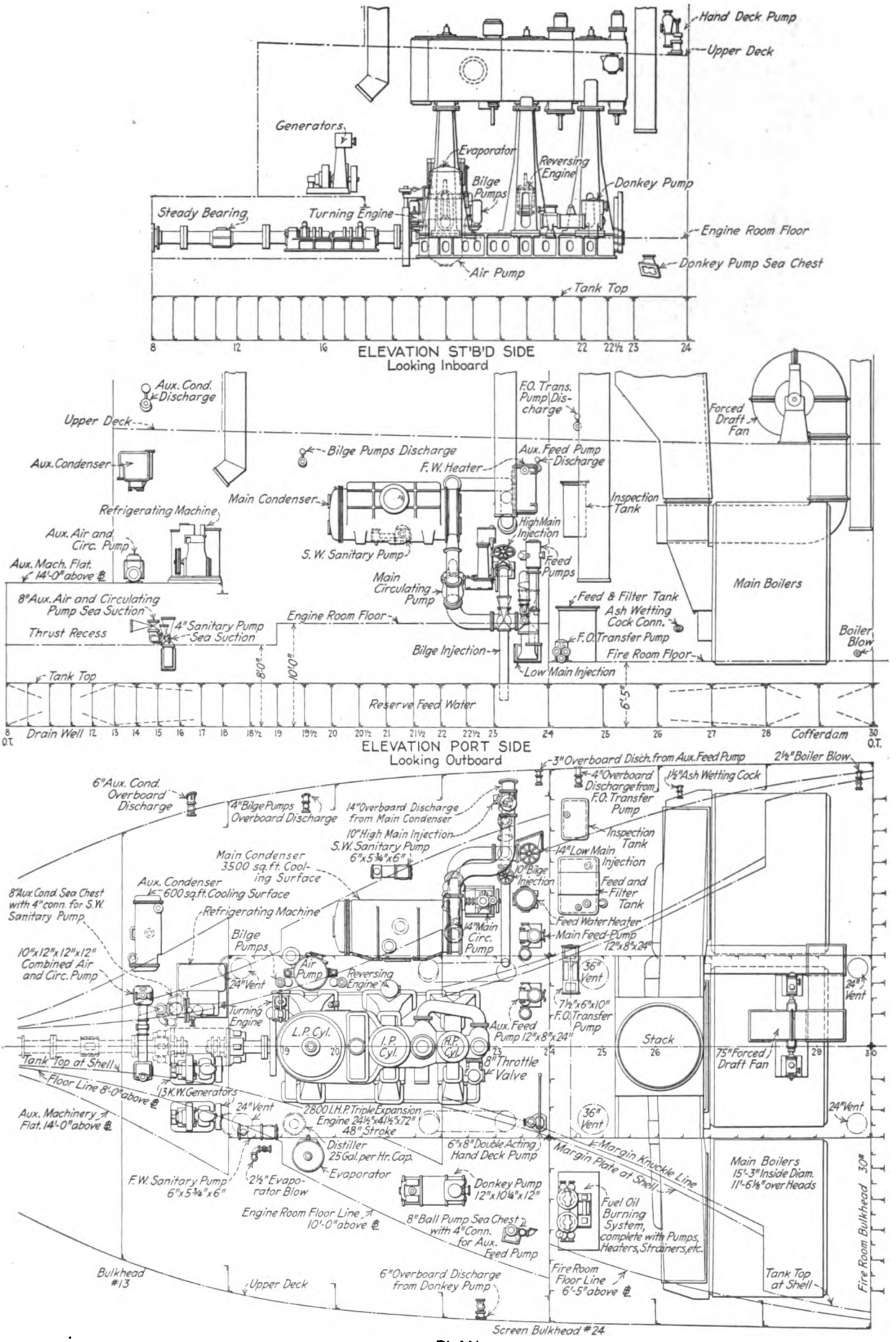

Fig. 5.—9,420 Deadweight Ton Tanker: Machinery Arrangement, Plan and Elevation

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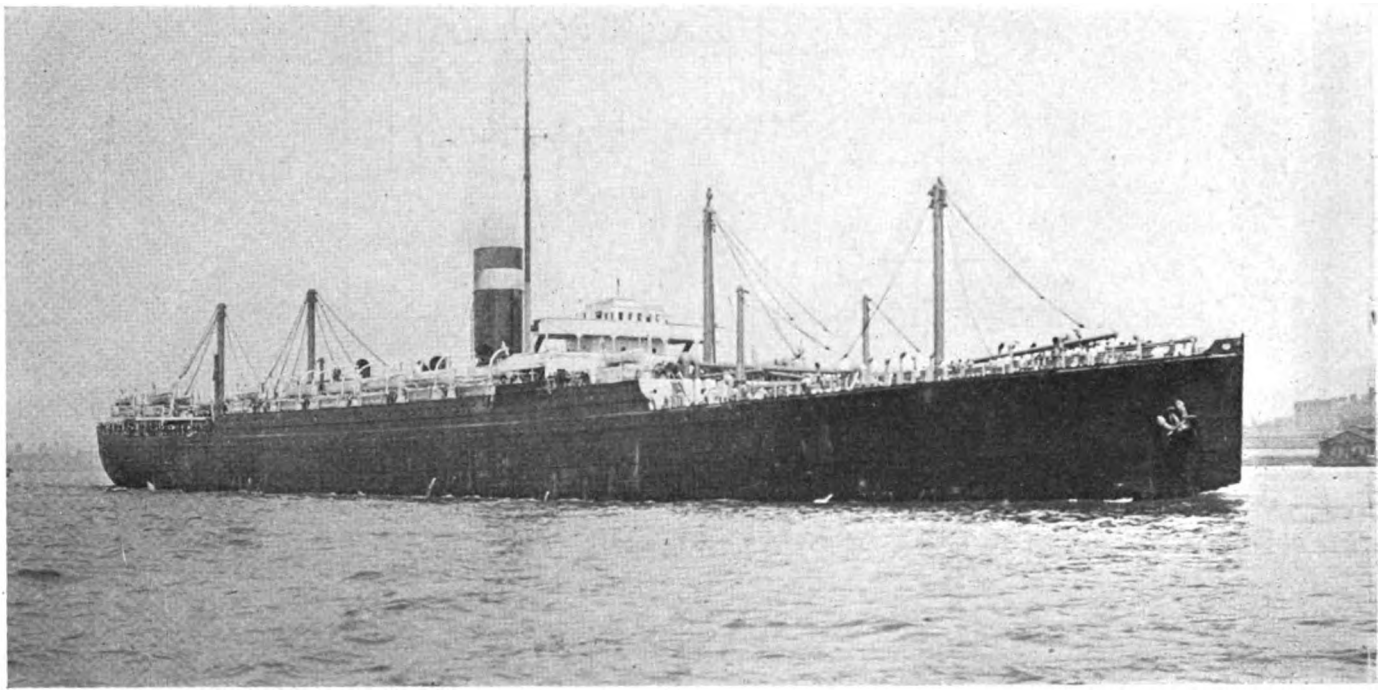

S. S. Minnekahda, 17,200-Ton One-Class Liner

The Minnekahda, A Ship of Democracy

One-Class Liner Built in Ireland, Reconditioned in the United States and Placed in American Service to Germany

POSSIBLY one of the most striking examples of tonnage adaptation in the development of shipping since the war is to be found in the *Minnekahda,* operated by the International Mercantile Marine Company under the colors of the American Line, and at present in service between New York and Hamburg, carrying third class passengers only.

This ship has been very widely advertised as a third class liner, and has caught the fancy of the thrifty travelers in that class through her status of a "ship of democracy," in which there can be no distinction between classes of passengers carried, since she carries but one.

It is in the ship's adaptation to her present use, however, that the average shipping man, designer, engineer or constructor will find the greatest material for study. The *Minnekahda* was constructed for a different line of business than the one she is now in, under a different flag, and in different structural form.

British Built

Built in a British yard, for the Atlantic Transport Company, the ship was designed to take her place in the famous "Minne" class of that company's line, operating between New York and London. The vessels of that class were large combination freight and passenger carriers, with accommodation for cabin business only. As such they were exceedingly popular before the war.

While the *Minnekahda* was taking shape at the Harland & Wolff yards at Belfast, the four "Minne" ships were sent to the bottom one after another by German submarines—the *Minneapolis, Minnetonka, Minnewaska* and *Minnehaha.* Before the new ship was ready for launching, the Allies were straining every nerve to secure adequate transport tonnage. Therefore the *Minnekahda* was rushed overboard in 1917 without her passenger-deck houses or fittings, and equipped as a transport. Her large carrying capacity in both supplies and troops made her specially valuable. Her war service was notable, and she served through the busy post-war years of 1919 and 1920 with profit to her owners.

Transferred to American Flag

In the fall of 1920 the International Mercantile Marine, the American company owning the Atlantic Transport Company, decided that in view of changed conditions, the time was not ripe to revive its London passenger trade, and devised other uses for the *Minnekahda,* in the new American Line service to Germany. In order to place her in this service, it was necessary to transfer her to the American flag. The British Government is not keen on allowing ships to be transferred from its registry, but arrangements for this transfer were agreed to by the Board of Trade, and on November 3, 1920, the British ensign was hauled down on the *Minnekahda* at New York. and the Stars and Stripes were raised on her ensign staff by P. A. S. Franklin, president of the International Mercantile Marine Company. The ship is the largest ever transferred from British to American registry.

Reconditioned in American Yard

The ship was then taken in hand for adaptation to her new uses. A contract was made with the Bethlehem Ship Building Corporation to do the work at its Fore River plant, Quincy, Mass., and the ship was sent there the second week in November. The job was scheduled for completion in March. Working from plans prepared under the direction of William F. Gibbs, chief constructor for the International Mercantile Marine Company, the Fore River plant had the vessel ready for delivery several days ahead of the agreed

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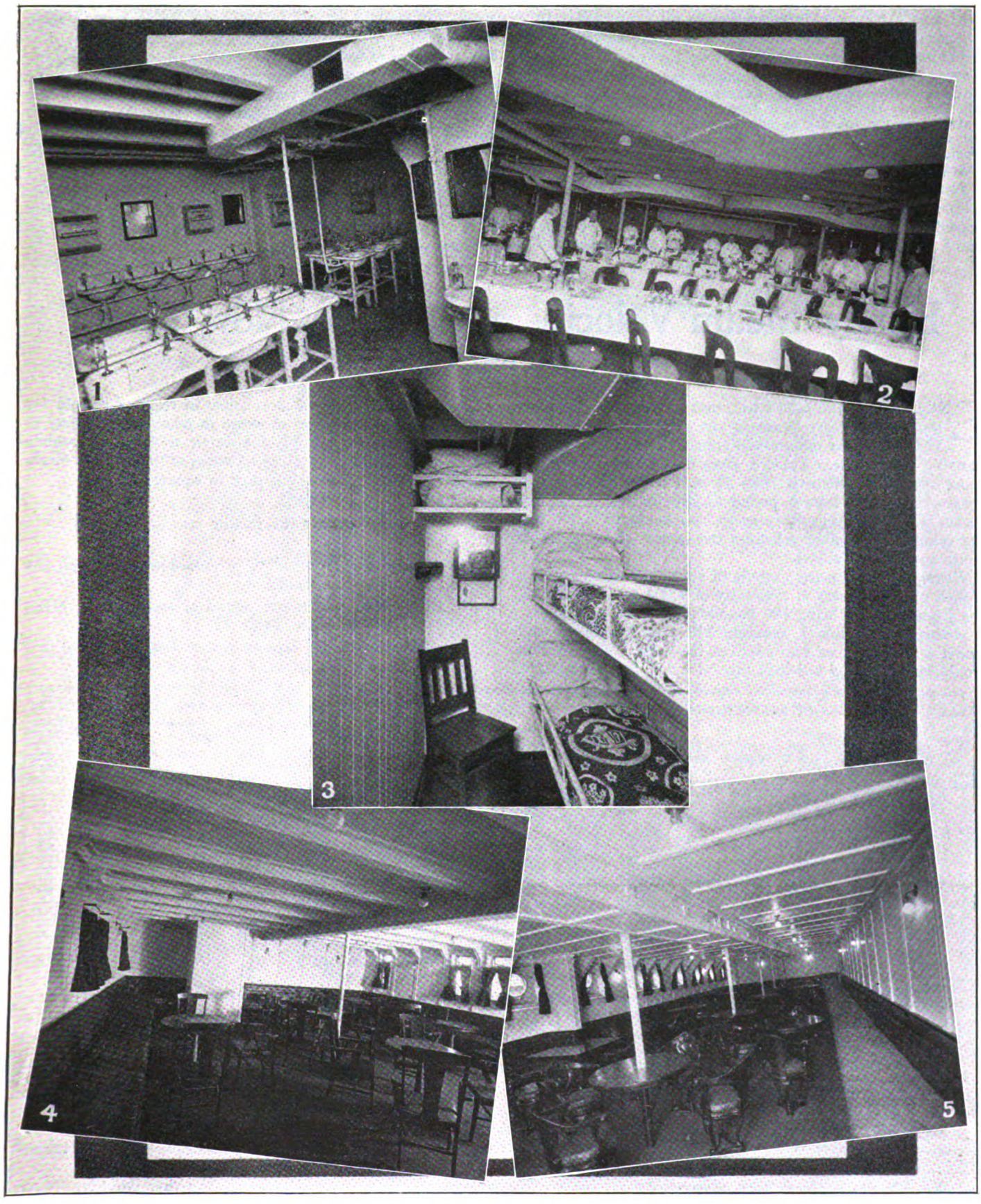
INTERIOR VIEWS OF THE AMERICAN LINER MINNEKAHDA



S. S. Minnekahda: (1) Lavatory, (2) Dining Saloon, (3) Two-Berth Stateroom, (4) Smoking Room, (5) Lounge.

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date. The ship left the yard, complete in every detail, on March 15, and after docking proceeded to New York to load for her first voyage. The job on her had been a big one, calling for an expenditure of about $700,000, and the creditable manner in which it was done in an American yard was a source of gratification to all concerned. In a statement made at the time the ship was delivered, Mr. Gibbs had this to say about the job:

"The work of completing this ship to carry passengers might have been done abroad, before her transfer to American registry. The company chose to have it done here. The workmanship and materials in the job are as good as can be found anywhere in the world. The completion of the work reflects the greatest credit on the yard, as the installation of the passenger fittings embodies the latest ideas in equipment and quality."

As completed, the *Minnekahda* is without the upper deck originally designed for her, which gives her a rather rakish appearance, since her deck heights are less than are usually found on a vessel of her length, 640 feet. Her beam is 66.4 feet. The ship has ample space for 2,150 passengers, with adequate deck space for open air exercise.

ARRANGED LIKE FIRST CLASS LINER

In equipment the *Minnekahda* is not unlike a first class liner, with public rooms, including a dining room seating four hundred, a large lounge and two smoking rooms. She has a number of two-berth, four-berth and six-berth sleeping rooms, all neatly equipped, and dormitory spaces for single men and single women, partitioned off with canvas. The walls of the sleeping quarters are done throughout in white enamel. The floors have sanitary coverings. There is a complete and satisfactory ventilating system, and her plumbing equipment is of the best.

The *Minnekahda* has triple screws. Her power plant consists of two triple expansion reciprocating engines exhausting into a low pressure turbine on the center shaft. Steam is supplied by Scotch boilers.

Handy Steam Velocity and Steam Flow Tables*

By V. F. Davis

ENGINEERS and others who make a practice of designing pipe to carry steam at any velocity from 2,000 to 12,000 feet per minute will appreciate the tables accompanying this article. Table 1 gives the capacities of steam pipes varying in diameter from ¾ inch to 15 inches, steam pressures varying from 1 pound to 250 pounds per square inch. The steam velocity in every case is exactly 6,000 feet per minute. For other velocities the factors given in Table 2 are applied to Table 1.

Example: How many pounds of steam per minute will a 2-inch pipe line carry at a velocity of 7,000 feet per minute, the steam pressure being 200 pounds per square inch gage?

Answer: In Table 1, opposite 200 pounds pressure and under 2-inch pipe, we find 65.32 as the weight of steam that would be carried by a 2-inch pipe at 6,000 feet per minute.

To find the velocity of steam flow in feet per minute for a given pipe size and flow of steam in pounds per minute at any given pressure, multiply the weight of steam in pounds by the cubic feet in one pound of steam at the given pressure and divide by the area of the pipe in square feet, or

$$\text{Velocity in feet per minute} = \frac{w \times D_1}{A}$$

Where w = weight of steam in pounds flowing through the pipe (see Table 1).

D_1 = cubic feet in one pound of steam at the given pressure (see Table 1).

A = area of the pipe in square feet (see areas just below pipe sizes in Table 1).

TABLE 1.—CAPACITIES OF STEAM PIPES IN POUNDS PER MINUTE WITH A STEAM FLOW VELOCITY OF 6,000 FEET PER MINUTE

Steam Pressure in Lbs. Per Sq. Inch Gage	Weight of Steam Per Cu. Ft. in Pounds	Cu. ft. in (1) Lb. of Steam = D_1	Diameter of pipe in inches = d_1 Area of pipe in square feet = A_1 ¼" 0.0037	1" 0.0060	1¼" 0.0104	1½" 0.0141	2" 0.0233	2½" 0.0332	3" 0.0513	4" 0.0884	5" 0.1389	6" 0.2006	8" 0.3474	10" 0.5476	12" 0.7854	15" 1.268	Steam Pressure in Lbs. Per Sq. Inch Gage
			Weight of Steam in Pounds Per Minute = $A_1 \times 6000 \div D_1$														
1	.0396	25.23	.879	1.426	2.473	3.394	5.541	7.586	12.19	21.02	33.03	47.70	81.82	130.2	186.7	301.5	1
5	.0490	20.38	1.089	1.766	3.061	4.151	6.859	9.774	15.10	26.02	40.89	54.14	101.2	161.1	231.2	373.3	5
10	.0606	16.49	1.346	2.183	3.784	5.130	8.477	12.08	18.60	32.16	50.52	72.98	125.1	198.5	285.7	461.3	10
20	.0834	11.99	2.018	3.002	5.204	7.055	11.65	16.61	25.67	44.23	69.50	100.3	172.1	274.0	393.0	634.5	20
30	.1058	9.45	2.349	3.809	6.603	8.941	14.79	21.07	32.57	56.12	88.19	127.3	218.3	347.6	498.7	805.0	30
40	.1278	7.82	2.813	4.693	7.979	10.81	17.87	25.47	39.36	67.82	105.9	153.9	263.9	420.1	602.6	972.8	40
50	.1497	6.68	3.323	5.389	9.341	12.66	20.92	29.82	46.07	79.40	124.7	180.1	309.0	491.8	705.4	1138.	50
60	.1715	5.83	3.807	6.174	10.70	14.51	23.97	34.16	52.83	90.97	142.9	206.4	354.0	563.5	808.3	1305.	60
70	.1930	5.18	4.285	6.949	12.11	16.33	26.98	38.45	59.42	102.3	160.8	232.3	398.5	634.0	909.7	1468.	70
80	.2141	4.67	4.753	7.708	13.36	18.11	29.93	42.65	65.91	113.5	178.4	257.7	442.0	703.5	1009.	1627.	80
90	.2358	4.24	5.235	8.490	14.71	19.95	32.97	46.97	72.59	125.0	196.4	283.8	486.8	774.9	1111.	1794.	90
100	.2570	3.89	5.706	9.254	16.04	21.74	35.93	48.63	79.12	136.3	214.2	335.1	530.6	844.6	1211.	1955.	100
120	.3003	3.33	6.666	10.81	18.73	25.40	41.98	59.81	92.43	159.2	250.2	361.4	619.9	986.6	1414.	2284.	120
150	.3636	2.75	8.072	13.09	22.69	30.76	50.83	72.43	111.9	192.8	303.0	437.6	750.6	1194.	1713.	2766.	150
200	.4672	2.14	10.37	16.82	29.15	39.53	65.32	93.08	143.8	247.8	389.4	562.4	964.6	1534.	2201.	3555.	200
250	.5714	1.75	12.68	20.57	35.65	42.62	79.82	113.8	175.8	303.0	419.0	687.7	1179.	1877.	2692.	4347.	250

Areas of pipe are actual areas of standard pipe.

For 7,000 feet per minute Table 2 gives the factor of 1.166, or, 65.32 x 1.166 = 76.2 pounds per minute.

Table 1 is also very convenient for computing steam velocities through any ordinary pipe under pressures up to 250 pounds per square inch.

TABLE 2.—FACTORS TO BE APPLIED TO TABLE 1 TO FIND THE CAPACITY OF PIPE AT OTHER VELOCITIES

Velocity in Feet Per Minute	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	12,000
Factor	0.333	0.500	0.666	0.833	1.000	1.166	1.333	1.500	1.666	2.000

Example: What is the velocity of steam in feet per minute through a 4-inch pipe delivering 104 pounds of steam per minute at 100 pounds gage pressure per square inch?

Answer: From Table 1 we find the cubic feet in one pound of steam at 100 pounds pressure = 3.89. Then the steam flow in cubic feet per minute = 104 x 3.89 = 404.5 Now from Table 1 we also find the area of a 4-inch pipe in square feet = .0884. Hence, the velocity of steam flow = 404.5 ÷ .0884 = 4,573 feet per minute.

With the data given in these tables either the quantity or velocity of steam delivered by various sizes of pipes can be determined quickly, the other factors being known.

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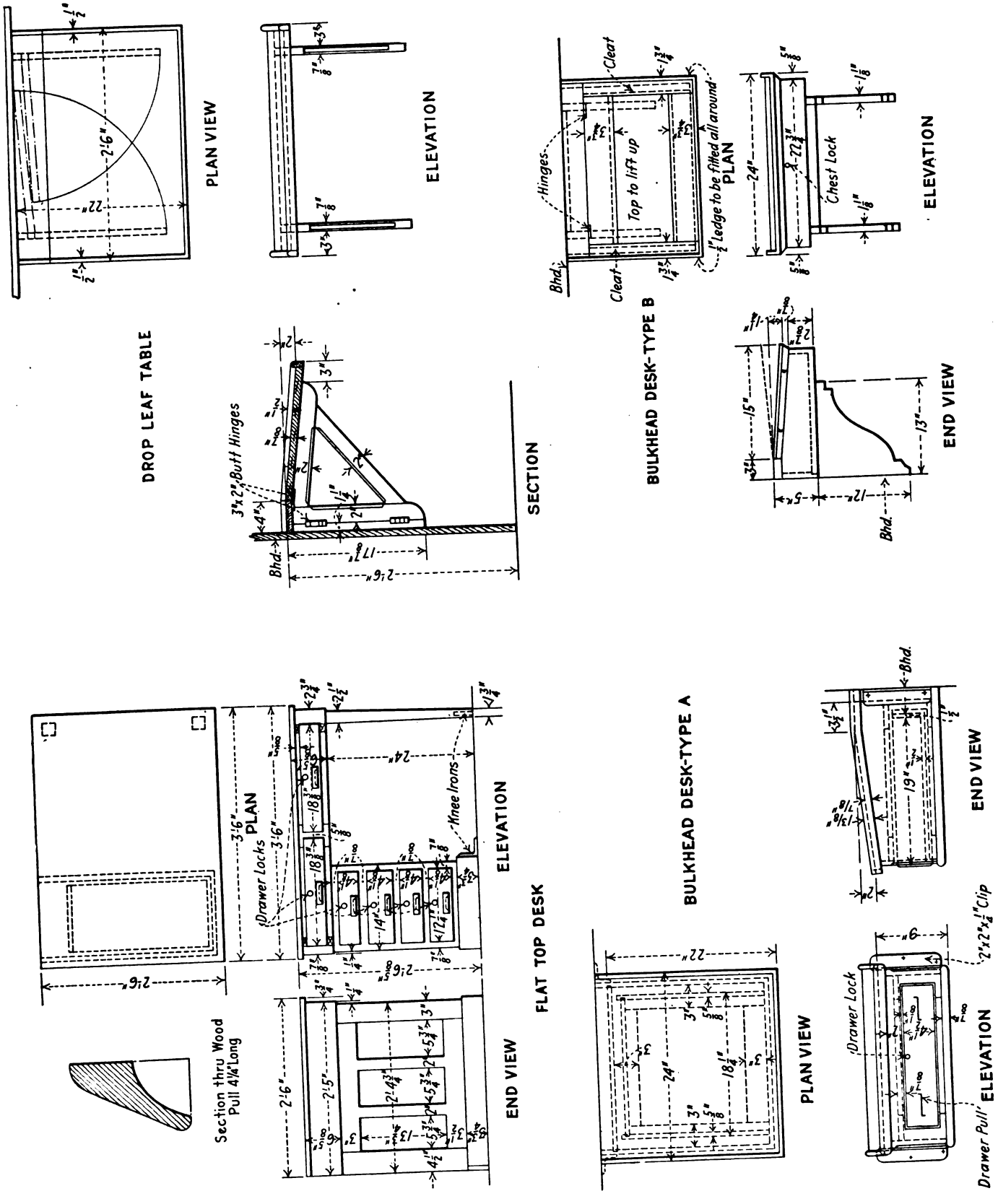
Ship Joiner Plans

Desks



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(9) Copper 62 percent, zinc 30 percent, lead 3 percent, iron 2 percent, with 3 percent of nickel or tin, or nickel and tin. This is the Navy Department composition B-c for commercial brass.

This alloy is of value for—
Name and number plates.
Cases for instruments.
Oil cups.
Distribution boxes.
Protection of joiner work.

MANGANESE BRONZE

Manganese bronze is in reality a brass. It was invented by Mr. P. M. Parsons whose compositions are extensively used in this country as well as in England. Manganese is a deoxidizing agent and its use increases the strength, ductility and homogeneousness of the alloy, which is remarkably hard, tough and elastic.

(10) Copper 53 percent to 62 percent, zinc 45 percent to 36 percent, tin 2 percent.

(11) Copper 55 percent to 60 percent, zinc 42 percent to 38 percent, tin 0 percent to 1.5 percent, manganese 0 percent to 3.5 percent, aluminum 0 percent to 1.5 percent, iron .1 percent to 2 percent and lead as an impurity up to .2 percent. This is the Navy composition Mn-c.

(12) The Bureau of Engineering is revising the above specifications and these revised specifications will be ready for issue in the near future. A maximum iron content of 2 percent is permitted.

Manganese bronze is used extensively for propellers and other work requiring great strength and incorrodibility. The uses for which this alloy is specially adapted are—
Solid propellers.
Propeller blades.
Rudders and rudder fittings.
Stuffing boxes and stern bearings of wooden vessels.
Propeller blade bolts.

ROLLED OR DRAWN BRASS

Mixtures for rolled or drawn brass most frequently met with in shipbuilding are—

(13) Copper 80 percent to 85 percent, zinc 20 percent to 15 percent, with allowable impurities of not over .1 percent iron and not over .5 percent lead.

This alloy is used for the manufacture of rigid seamless and lock seam voice tubing and is the Navy composition for the latter.

(14) Copper 70 percent, zinc 29 percent, tin 1 percent, with allowable impurities of not over .075 percent lead and .06 percent iron. This is the Navy composition A, called Admiralty metal.

This alloy is of value for—
Condenser tubes.
Distiller tubes.
Evaporator tubes.
Feed water heater tubes.
Condenser ferrules.

(15) Copper 60 percent, zinc 40 percent.

(16) Copper 59 percent to 62 percent, zinc 41 percent to 38 percent, with allowable impurities of .6 percent lead and .2 percent iron.

This is the Navy composition D-r for Muntz metal.

MUNTZ METAL

This alloy is named Muntz metal after its inventor, who discovered that extreme proportions of 50 percent copper to 50 percent zinc, and 63 percent copper to 37 percent zinc, and all intermediate values, would roll and work at a red heat. As too much copper increased the difficulty of working the metal and too much zinc rendered the metal too hard when cold, he preferred the alloy to consist of about 60 percent copper and 40 percent zinc. The Bureau of Engineering of the Navy Department calls the cast metal of the above composition Muntz metal also and designates it as D-c, the specification being identical to the above except that iron is not referred to.

This alloy was at one time considered more durable than copper for ship sheathing and equally as efficient, and it almost entirely replaced copper for that purpose. It was found, however, that the corrosive action of sea water caused the alloy to decay. This alloy is of value for—
Construction plates, shapes and bars not subject to the action of sea water.
Bolts and nuts and other fastenings not subject to the action of sea water.
Piston rods of fresh water pumps.
Sheathing of fresh water vessels.
Condenser tubes, when tinned.
Sheets for flexible voice tubing.
Pipes, iron pipe sizes or plumbers' sizes.

(17) Copper 60 percent to 70 percent, zinc 40 percent to 30 percent, with allowable lead not over .5 percent.

This alloy is used for making up flexible metallic voice tubing, but Muntz metal will answer the purpose as well.

(18) Copper 65 percent, zinc 33 percent, lead 2 percent.

(19) Copper 59 percent to 68 percent, zinc 41 percent to 32 percent, with a maximum of 1.5 percent tin and 3 percent lead and with maximum allowable iron of .2 percent.

This is the Navy composition B-r for rolled commercial brass. It is used for—
Oil tanks and drip pans.
Brass oil and water piping.
Sheet brass for liners.
Protection of joiner work.
Hand rails.
Name and number plates.

(20) Copper 62 percent, zinc 37 percent, tin 1 percent.

(21) Copper 59 percent to 63 percent, zinc 40.5 percent to 35.5 percent, tin .5 percent to 1.5 percent, with maximum allowable impurities of .2 percent lead and .06 percent iron. This is the Navy composition N-r for rolled naval brass.

Like the cast naval brass this alloy is used where strength or incorrodibility or both are factors. It will be noted that it is practically Muntz metal with a small addition of tin; and this small amount of tin is found to protect it against the corrosive action of sea water referred to above. It is of value for—
Construction plates, shapes and bars.
Moldings and chafing bars.
Condenser tube sheets and ferrules.
Condenser tube supporting plates.
Sheathing of wooden ships.
Operating rods.
Pump rods.
Studs and nuts.
Pins.
Pipe casings for piston rods and plungers.

MANGANESE BRONZE

The nature of this alloy has been explained under the heading of brass castings. It is also suitable for forgings.

(22) Copper 57 percent to 60 percent, zinc 40 percent to 37 percent, tin .5 percent to 1.5 percent, manganese not over .3 percent, iron not over 2.0 percent and lead not over .2 percent. This is the Navy composition Mn-r for rolled manganese bronze.

This alloy is of special value for rods requiring great strength where subject to corrosion, particularly the corrosion of salt water. Some of its uses are—
Valve stems.
Operating rods.
Propeller blade bolts.
Air pump bolts.
Condenser bolts.
Stuffing box bolts and studs.
Sheathing of wooden ships.
Machine bolts and nuts generally.

TOBIN BRONZE

(23) Tobin bronze is a proprietary composition whose exact mixture is not published by its manufacturers. Analyses of the metal as found in engineering handbooks show it to be very similar in composition to (22) though with less iron and no manganese. It meets the requirements of the Navy specifications (21) for rolled naval brass, which allow only .06 percent iron, and probably contains a fraction of a percent of other metals used by the makers to bring about the desired results.

This composition has great tensile and torsional strength and great resistance to the corrosive action of sea water. Results from its use have been consistently successful, and it has been found to be a most desirable alloy for—
Plates and shapes of bronze yachts and other vessels where in contact with salt water.

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Rudders and rudder stocks.
Condenser tube sheets.
Condenser tube supporting plates.
Pump valves.
Pump rods and valve stems.
Propeller shafts of small vessels in salt water service.
Wooden ship sheathing.
Hinge pins.
Bolts, screws, nails and other fastenings in contact with salt water.
Deck and spar fittings of yachts.

BRONZES

Turning our attention now to the true bronzes, we find a number of alloys that are of particular value for severe duty along various lines. With copper and tin as the principal elements, zinc is added to soften them and assist in making sound castings and lead, as with brass, is a softening element and improves the machining qualities. There are other metals sometimes introduced for special purposes which will be explained later. The hardness of bronze varies almost directly with the percent of tin in the mixture. Good alloys may be made which contain as much as 20 percent of tin but bronzes with 25 percent of tin or more are valueless to the shipbuilder.

All straight bronzes should be rejected which contain sulphur in an appreciable amount, more than .1 percent of arsenic and antimony united and more than .06 percent of iron.

BRONZE CASTINGS

Mixtures for castings most frequently met with in shipbuilding are—

(24) Copper 88 percent, tin 10 percent, zinc 2 percent.

(25) Copper 87 percent to 89 percent, tin 11 percent to 9 percent, zinc 1 percent to 3 percent, with allowable impurities of not over .2 percent of lead and not over .06 percent of iron. This is the Navy formula G for gun metal, of which (24) is the usual shipyard version.

This alloy is of particular value for castings where strength or resistance to corrosion, or both, at ordinary temperature are required; but it loses its strength rapidly with increase of temperature above 500 degrees F. It is of particular value for—

Spring and strut bearings of shafting.
Bearing boxes of blowers.
Distance pieces in journal boxes.
Stern tubes or bushings.
Shaft and rudder stock liners or sleeves.
Propeller nut caps.
Pump casings.
Pump valve seats and buckets.
Valves bodies 4 inches diameter and over except for superheated steam.
Seats and disks in high pressure steam valves.
Expansion joints.
Pipe flanges.
Pipe fittings.
Gear wheels.
Bolts and nuts.
Pad eyes and ring bolts.
Stuffing boxes and bushings.

(26) Copper 83 percent, tin 13.5 percent, zinc 3.5 percent.

(27) Copper 82 percent to 84 percent, tin 14.5 percent to 12.5 percent, zinc 2.5 percent to 4.5 percent, lead 1 percent as a maximum with allowable iron up to .10 percent. This is the Navy formula H for journal bronze.

This alloy is essentially a bearing metal and is of value for all such service where its tendency to brittleness, due to the high tin content, is not a drawback. Ordinary uses are—

Bearings.
Journal boxes.
Journal bushings.
Suspension link brasses.
Sleeves.
Slippers.
Guide gibs.
Link block gibs.
Piston rod and valve stem neck and gland bushings of main engines.
Wedges on watertight doors.

(28) Copper 87 percent, tin 7 percent, zinc 5 percent to 6 percent, lead 1 percent as a maximum, with allowable iron up to .06 percent. This is the Navy formula M for valve bronze.

This alloy is almost a brass, rather than a bronze, being quite close in composition to (3). It has too much zinc for severe steam pressure service, but is of value for—

Bodies of valves below 4 inches, for steam and general purposes.
Manifolds.
Cocks.
Hose couplings and fittings.
Stuffing box glands and gland bushings.
Castings of skylight and ventilator operating gear.
Lug sockets and pad eyes requiring no special strength.
Bitts, chocks, cleats and fairleads.
Airports.
Sea connections.

(29) Copper 78 percent, tin 22 percent.

This alloy is bell metal, for ships' bells, and should be made of new Lake Superior copper, or equal, and new block tin.

PHOSPHOR BRONZE

This is a bronze alloy which has been given exceptional purity and excellence by skilful fluxing with phosphorus. Copper, tin and lead tend to form oxides readily, and phosphorus, like manganese, is an excellent deoxidizer and thus prevents structural weakness. It is usually added in excess of the amount required for this purpose and when so added increases the value of the alloy as a bearing metal, as explained under the heading of bearing metals. The resultant alloy is harder and stronger than ordinary gun metal, and very close grained.

(30) Copper 89 percent, tin 10.5 percent, phosphorus .5 percent.

This composition is of value where a very hard bearing metal is desired for such service as liners for connecting rod wrist pins in Diesel engines.

(31) Copper 78 percent to 82 percent, tin 9 percent to 11 percent, lead 9 percent to 11 percent, phosphorus .1 percent to .25 percent.

This composition has been adopted by one or more of the large manufacturers of marine engines for heavy pressure and high speed bearings and those subjected to shock and vibration.

(32) Copper 85 percent to 90 percent, tin 11 percent to 6 percent, zinc 4 percent maximum, phosphorus .5 percent maximum, with allowable lead up to .2 percent and allowable iron up to .06 percent. This is the Navy composition P-c, grade 1.

(33) Copper 85 percent to 90 percent, tin 11 percent to 6 percent, zinc 9 percent to 4 percent, phosphorus .5 percent maximum, with allowable lead up to 1 percent and iron up to .1 percent. This is the Navy composition P-c, grade 2.

This alloy is of special value for items which are exposed to the action of salt water and require good bearing qualities. Grade 2 should be used only where great strength is not required. An alloy at the high limit of the tin and phosphorus is much harder than one at the low limit. The special uses are—

Driving nuts of hand steering gears.
Worm gears.
Gear wheels on steering rods.
Cast piston rods and pump rods.
Shaft liners and pump casings.
Rudder pintle casings.
Machinery bearings where journal bronze might prove too brittle.
Slide valves.
Bearing rings.

ROLLED OR DRAWN BRONZE

Bronzes do not lend themselves readily to forging operations. An alloy with as much as 5 percent tin can only be worked hot and with 15 percent of tin it cannot be forged hot or cold. It is perhaps for this reason that Tobin bronze, manganese bronze and other rolled brass alloys are able to

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appropriate the name of bronze. Rolled or drawn phosphor bronzes containing small percentages of tin are, however, of great value to the shipbuilder.

(34) Copper not less than 94 percent, tin not less than 3.5 percent, phosphorus .05 percent to .5 percent, with allowable impurities of not over .3 percent zinc, .1 percent iron and 2 percent lead, and with the total content of copper, tin and phosphorus not less than 99 percent. This is the Navy composition P-r.

This alloy is of value for—
- Valve stems.
- Pump rods.
- Pump valves.
- Bolts, screws, etc.
- Wire rope.

For rods, bolts and wire the low limit of tin, and phosphorus not to exceed .1 percent, are the most desirable.

(35) Copper 94 percent, tin not less than 4.5 percent, phosphorus .05 percent to .5 percent, with allowable impurities of not over .3 percent zinc, .1 percent iron and .2 percent lead. This is the Navy composition for spring wire, hard drawn or hard rolled.

This alloy is of value for such service as—
- Slide valve packing ring springs.
- Valve springs.

Special Alloys

A few special alloys which do not have copper and zinc or copper and tin as their principal elements will be now considered.

Monel Metal

Monel metal is a natural alloy containing 67 percent to 68 percent nickel, 28 percent to 30 percent copper and 2 percent to 5 percent of other metals, principally iron. The proportions are practically the same as those of the ore as it comes from the only known deposit, a mine near Sudbury, in Ontario, Canada. The iron is in the original ore and small quantities of manganese, silicon and carbon are introduced in the process of refining.

Monel metal is non-corrodible, tough and ductile. It has the appearance of steel though it is difficult to distinguish from pure nickel and takes and retains a nickel polish. It can be cast, forged, rolled, drawn, welded, brazed or soldered; and it is comparatively easy to machine. The tensile strength of the rolled metal exceeds nickel steel at ordinary temperatures, and at a high temperature it is far superior to nickel steel. It is remarkably free from erosion or corrosion by steam or water; shows little wear when used for pump liners and acquires a glass like surface. It has a coefficient of expansion very similar to that of steel, which together with its resistance to the effects of heat has led to its use for valve stems, disks and seats in cast steel valves for superheated steam work.

(36) The Navy formula for Monel metal, either cast or rolled, is nickel not less than 60 percent, copper not less than 23 percent, iron not over 3.5 percent, manganese not over 3.5 percent, aluminum not over .5 percent, and carbon and silicon combined not over 2.0 percent.

This alloy is of special value for—
- The highest grade of propeller blades.
- Turbine blading.
- Condenser tubes.
- Valves, valve stems, liners and piston rods of salt water pumps.
- Composition fittings in the refrigerating system.
- Valves and valve seats of internal combustion engines.
- Disks, seats and stems of valves handling superheated steam.
- Disks and seats of boiler safety valves.
- Engine framing.
- Boat fittings.

Aluminum Bronze

Aluminum bronze is a mixture of copper and aluminum with usually a small percentage of iron. It is one of the strongest and most valuable bronzes yet discovered, but its high cost when first discovered and more recently the difficulty experienced in handling it in the foundry, when the cost of aluminum came down, have to date militated against its extensive use in the shipbuilding field. It is malleable at red heat.

(37) Copper 88.5 percent to 89 percent, aluminum 10 percent, iron 1 percent to 1½ percent.

This alloy is very valuable for worm gears and similar service.

Bearing Metals

Turning our attention now to bearing metals we find that a bearing metal has to fulfill many requirements, among the most important of which are—

(a) The hardest element in it must be softer than the shaft or pin so as not to injure them.
(b) The metal should be plastic to a limited degree for the reason that the fitting of it is only an approximation and also to enable it to conform to a change in alinement of the shaft. It should, however, be strong enough to carry the load without distortion.
(c) It should show small friction. This for such duties as are met with on shipboard calls for a surface that will retain the lubrication.
(d) It should conduct and radiate the heat of friction readily.
(e) It should be of a nature not to weld to the shaft in case it becomes heated.
(f) It should wear slowly.
(g) It should be capable of uniform production and be easy to handle in the foundry.

Some of the bronzes and the babbitts have the desired combination of properties. Alloys of about two-thirds tin and one-third zinc with a little copper or antimony, called white brass, also make good hard bearing metals; but they are not extensively used on account of their difficult handling. The true brass is not satisfactory because it does not fulfill requirement (c) above, and the expression "bearing brasses" is a misnomer, as far as what is generally known as brass is concerned. A brass bearing is dry and harsh. Bronzes are used where their strength and hardness are necessary to fulfill the particular requirements of the service or to have sufficient life, and babbitts are used for the less severe duties. Bronzes can be given a wide range of hardness by increasing the zinc or lead. Babbitts also have a wide range of hardness and there are many mixtures between the limits of 90 percent tin with no lead and 90 percent lead with no tin. With bronzes the harder element is the major constituent, whereas with babbitts it is the minor constituent. Babbitts are of no value for such service as brasses, gibs, etc., but should only be used when poured and hammered into suitable recesses in the bearing boxes provided for this metal.

The surface of a bronze bearing consists of a hard copper-tin background with softer crystals formed by other elements in composition with the copper or tin, or softer globules of the other elements. These soft crystals or globules wear more rapidly than the background, thus producing small reservoirs which retain the oil. A small amount of phosphorus in excess of that required as a deoxidizer furnishes an additional hard constituent, which is one of the factors in the value of phosphor bronze as a bearing metal. A small amount of lead imparts plasticity to a bearing bronze and also furnishes additional oil reservoirs.

The surface of a tin base babbitt bearing consists of a relatively soft tin background with harder tin-antimony, copper-tin or copper-antimony crystals in it. The background in this case wears first, forming reservoirs which retain the oil. With the lead base babbitts the background is lead or a mixture of lead and tin and the harder crystals are the tin-antimony compound.

This ability to provide oil reservoirs is not a property of the brass alloys, and is the reason for their not being good bearing metals, as previously mentioned.

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The Brinell hardness test is of value for determining the properties of a bearing metal, particularly when its general composition is known; and machines for making such tests are readily obtainable. The test consists of indenting the surface of the metal by a hard steel ball of fixed diameter, under a fixed pressure, for a fixed period of time. The hardness figure is the quotient of the pressure applied on the ball divided by the surface of the indentation. This surface can be readily determined from the depth or diameter of the impression, preferably the former. Hardness figures usually met with are for the metal at 70 degrees F.

BEARING BRONZES

These bronzes as most frequently used in shipbuilding have been already presented and their value as bearing metals touched upon. To group them together as bearing metals they are—

(27) Journal bronze-copper 82 to 84 percent, tin 14.5 to 12.5 percent, zinc 2.5 to 4½ percent, lead up to 1 percent.

(32) Phosphorus bronze-copper 85 to 90 percent, tin 11 to 6 percent, zinc 4 percent, phosphorus up to .5 percent and lead up to .2 percent.

The first mentioned alloy takes in the general run of machinery bearings while the second is of particular value where the bearing is of the nature of a nut on a screw, or one gear wheel against another, or shaft bearings in salt water; as may be noted from the lists of service previously given.

WHITE BRASSES

These alloys, which have been already referred to, are used in recessed bearings in place of babbitt metal where it is important that the bearing shall have a long life under conditions of severe service. The usual composition met with in shipbuilding fall within the range of tin 60 percent to 65 percent, zinc 33 percent to 28 percent, copper 3 percent to 6 percent with a small amount of lead.

(38) Parsons No. 2 This is a proprietary alloy of the above nature with possibly a slightly higher tin content and possibly a small amount of antimony in place of a part of the copper. It has been used by the writer with very good results for the main bearings and connecting rod bottom ends of reciprocating propelling engines, and thrust shoes.

TIN BASE BABBITT

(39) Tin 84 percent, antimony 9 percent, copper 7 percent.

(40) Tin 83⅓ percent, antimony 8⅓ percent, copper 8⅓ percent.

These are about the hardest babbitts in commercial use, the first mentioned having been adopted by the Society of Automobile Engineers and also used in the Liberty motor, and the second adopted by a manufacturer of large heavy oil internal combustion engines.

(41) Tin 80 percent to 83.5 percent, antimony 11 percent to 15 percent, copper 5 percent to 5.5 percent.

This is the Navy composition W, grade B, adopted for all bearings of internal combustion engines.

(42) Tin 79 percent, antimony 13 percent, copper 3¾ percent, lead 4¼ percent.

This is the composition adopted by one of the large manufacturers of Diesel engines in this country for use in all babbitted bearings of these engines.

(43) Tin 91 percent, antimony 4.5 percent, copper 4.5 percent with allowable lead not over .2 percent.

This composition has been adopted by the International Aircraft Standards Board. Its hardness is about 83 percent of that of composition (40).

(44) Tin 88 percent to 89.5 percent, antimony 7 percent to 8 percent, copper 3 percent to 4.5 percent. This is the Navy composition W, grade A, and makes a good hard metal for general use.

(45) Tin 89.3 percent, antimony 3.6 percent, copper 7.1 percent. This is understood to be the composition adopted by Isaac Babbitt, the inventor of the recessed bearing into which bearing metal is poured.

All of these babbitts should have not over .08 percent iron, not over .10 percent arsenic, and no zinc or aluminum.

Tin base babbitt should be used for the great majority of recessed bearings on shipboard. The exceptions are the few cases where change of alinement or low pressure or intermittent service renders the lead base babbitt suitable. The tin base babbitt is very fluid when molten and desirable from this point of view as well as on account of greater hardness and longer life.

LEAD BASE BABBITT

(46) Lead 75 percent, antimony 15 percent, tin 10 percent.

This is about the hardest lead base babbitt in commercial use. It has about ⅔ the hardness of the hardest tin base babbitt.

(47) Lead 80 percent, antimony 15 percent, tin 5 percent.

This composition with slight variations is marketed with successful results by some of the concerns which make a specialty of lead base bearing metals.

(48) Lead 87 percent, antimony 13 percent.

This is a bearing metal adopted by one of our large railway systems, which claims that the addition of much more antimony will tend to make the metal brittle. It is one of the softest in commercial use.

(49) Lead 76 percent to 80 percent, antimony 18 percent to 13 percent, tin 5 percent to 6 percent, copper 1 percent.

This is the composition adopted by the Emergency Fleet Corporation for this type of bearing metal.

Lead base babbitts should contain not over .2 percent arsenic and no iron.

Lead base babbitt when properly poured is satisfactory for—

Line shaft bearings.
Rudder stock bearings
Miscellaneous bearings for high speed light duty work.
Miscellaneous bearings that are subject to little use.

SOLDERS

Solders are of two kinds, hard and soft. They are made of metals that have an affinity for and melt at a considerably lower temperature than the metals to be united.

The hard solder used for brazing copper pipes is usually a brass composed of about equal amounts of copper and zinc, i.e.:

(50) Copper 50 percent, zinc 50 percent.

Soft solder is usually a mixture of tin and lead, ranging from 50 percent to 33 percent tin and 50 percent to 67 percent lead, the best quality having the highest tin content. The addition of a small amount of antimony lowers the complete liquidation point, but antimony should not be used when galvanized iron or zinc are to be soldered. During the war, in order to conserve tin, consideration was given to the possibilities in the use of cadmium; and a composition consisting of 80 percent lead, 10 percent cadmium and 10 percent tin showed particular promise.

(51) Tin 45 percent, lead 55 percent, with allowable impurities of not over .12 percent antimony, .08 percent copper and .10 percent of other materials.

For hard soldering with an iron this solder will answer for all purposes.

(52) Tin 37.5 percent, lead 62.5 percent with allowable impurities as above.

This is a good wiping solder on account of the proportions of solid and fluid metal in the temperature range of about 110 degrees F. between the point where melting begins and where the solder is completely liquefied.

SUMMARY

In order to illustrate more clearly the uses of the brasses, bronzes and bearing metals which we have been considering, the writer will now present them in order in which ship specifications are usually written, pointing out the alloy called for by good merchant practice for the particular service. Although the alloys thus pointed out are those most generally met with, it should be understood that there are in most cases other alloys of somewhat different composition

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which will meet the demands of the service. Alloys which depart materially from general practice should, however, be very carefully investigated unless they have been thoroughly tried out or are required by the owner of the vessel. It should also be understood that in many cases, wrought or cast steel, semi-steel or malleable iron are used for the services mentioned, and sometimes preferably so used.

The designating numbers are those opposite the formulæ as previously given.

Table of Suitable Brasses, Bronzes and Bearing Metals for Ship Specification

	Items	Composition	Formula No.
1A	Hull Fastenings—		
	Fastenings of bronze vessels where exposed to salt water or weather	Tobin bronze	23
	Where not exposed to the above	Muntz metal	16
2A	Structural Items—		
	Plates and shapes of bronze vessels where exposed to salt water or weather	Tobin bronze	23
	Fin keels	Tobin bronze	23
	Interior plates and shapes of bronze vessels	Muntz metal	16
3A	Sheathing—		
	Sheathing of wooden vessels in salt water	Rolled manganese bronze	22
	Sheathing of wooden vessels in fresh water	Muntz metal	16
4A	Rudder—		
	Rudder plates	Tobin bronze	23
	Rudder stocks and posts	Tobin bronze	23
	Cast rudders and arms and pintles of wooden rudders	Cast manganese bronze	12
	Casings on steel pintles	Phosphor bronze	33
	Bearings of composition cased pintles	Tin base babbitt	44
	Underwater rudder stops on wooden ships	Cast naval brass	8
	Sleeve on rudder stock	Gun metal	25
	Rudder bearer ring	Phosphor bronze	33
	Rudder bearer bearing metal with bronze sleeve on stock	Lead base babbitt	49
	Rudder bearer bushing for steel stock	Phosphor bronze	33
	Rudder stuffing box bushing	Valve bronze	28
	Rudder stuffing box gland	Valve bronze	28
	Bearer and stuffing box bolts or studs	Tobin bronze	23
5B	Bulwarks—		
	Castings in way of portable bulwarks, etc	Cast naval brass	8
6B	Steel Doors, Ports and Hatches—		
	Coamings	Cast naval brass	8
	Hinges	Gun metal	25
	Bolts and nuts	Manganese bronze	12 or 22
	Handles	Hardware brass	4
	Bushings for handle bolts	Gun metal or naval brass	25 or 21
	Hinge pins and tumble bolt pins	Tobin bronze	23
	Operating rods	Rolled naval brass	21
	Operating rod gear wheels, worms or nuts	Phosphor bronze	32
	Dogs	Cast naval brass	8
	Dog wedges	Journal bronze	27
	Toggle pins	Rolled naval brass	21
	Rubber packing retainer	Rolled commercial brass	19
	Handhole covers	Screw brass	6
	Wide open and ajar hooks or fittings	Hardware brass	4
	Air vent valve castings	Gun metal	25
	Air vent valve forgings	Rolled naval brass	21
	Hand wheels	Brass	2
7B	Hatches with Wooden Covers—		
	Pad eyes	Gun metal	25
	Ring bolts	Gun metal	25
	Tarpaulin cleats	Cast naval brass	8
	Portable stanchions	Cast naval brass	8
	Portable stanchion sockets	Cast naval brass	8
8B	Ventilation, Light and Access Trunks and Skylights—		
	Frames of lights in steel shutters	Valve bronze	28
	Pins of shutter hinges	Rolled naval brass	21
	Toggle pins	Rolled naval brass	21
	Split pins and safety chains	Rolled commercial brass	19
	Nosings and wearing strips	Naval brass	8 or 21
	Operating rods	Rolled naval brass	21
	Operating rod hangers and rollers	Valve bronze	28
	Operating rod gear wheels, racks, etc	Phosphor bronze	33
	Lifting lugs	Valve bronze	28
	Hand wheels	Brass	2
9B	Mast and Boom Fittings—		
	Bearing rings	Phosphor bronze	33
	Pins for goosenecks, crow's nest, hinges, etc	Tobin bronze	23
10B	Pipe Casings—	Rolled naval brass	21
11B	Moldings and Chafing Bar	Rolled naval brass	21
12C	Bitts, Chocks, Cleats, Fairleads—		
	When all of composition	Valve bronze	28
	Brass caps for wooden bitts	Valve bronze	28
	Babbitt for chocks, bitt heads and thumb cleats	Lead base babbitt	49
13C	Eye bolts and ring bolts*	Gun metal	25
14C	Davit Steps and Guides	Cast naval brass	8
15C	Manholes and Scuttles (See also 6B)—		
	Rings, covers and gratings	Screw brass	6
	Locking studs	Gun metal or naval brass	25 or 21
16C	Fittings for Metal Hatches (See 6B)—		
17C	Freeing Ports, Scuppers and Drains—		
	Deck and hull castings	Cast naval brass	8
	Strainers	Cast naval brass	8
	Flapper valves	Cast naval brass	8
	Freeing port dogs	Cast naval brass	8
	Freeing port hinges	Gun metal	25
	Bolts, studs and nuts	Rolled naval brass	21
	Drain plugs in bottom	Screw brass	6
18C	Airports and Fixed Lights—		
	Frame, rim for glass, ring nuts	Valve bronze	28
	Bolts	Gun metal	25
19C	Ventilators—		
	Ring nuts and pinch screws	Screw brass	6
	Vent operating gear (See 8B)		
20C	Rail and Awning Stanchions, etc.—		
	Stanchions	Cast naval brass	8
	Stanchion and ridge pole heads and feet	Cast naval brass	8
	Spreader sockets	Cast naval brass	8
	Stanchion clamps	Cast naval brass	8
	Rails and rods	Rolled commercial brass	19
	Fittings on wooden rails	Cast naval brass	8
	Bolts and nuts	Rolled naval brass	21
21C	Skylight Fittings— (See 8B)		
22C	Miscellaneous Hull Fittings—		
	Flag pole sockets and guides	Cast naval brass	8
	Deck plates and caps	Screw brass	6
	Deck stuffing boxes and caps	Screw brass	6
	Deck stuffing box glands	Screw brass	6
23D	Joiner Work—		
	Tie rods, bolts, etc., in way of standard compass	Muntz metal	16
	Protection on doors, sills or stairs	Commercial brass	9 or 19
	Fittings on rails, grab rails, etc	Cast naval brass	8
	Hinges	Hardware brass	4
	Pins of steel hinges	Tobin bronze	23
	Ajar hooks and wide open hooks	Hardware brass	4
	Cast hardware generally	Hardware brass	4
24E	Name Plates, etc.—		
	Ship and engine name plates	Commercial brass	9 or 19
	Letters for name and hailing port	Cast naval brass	8
25F	Cables, Lines and Rigging—		
	Ropes	Phosphor bronze	34
	Cable shackle pin keepers	Rolled naval brass	21
26F	Blocks—		
	Bushings for sheaves	Phosphor bronze	33
27F	Ship's Bells—		
	Body	Bell metal	29
	Clapper and pin	Gun metal	25
28F	Accommodation Ladder, Leadsman Platform, etc.— (See 20C and 23D)		
29G	Hull Machinery—		
	Piston rods and valve stems	Tobin bronze	23
	Crosshead and crank pin brasses	Journal bronze	27
	Stuffing boxes or neck bushings	Gun metal	25
	Glands or gland bushings	Valve bronze	28
	Gland studs	Rolled naval brass	21
	Slippers	Journal bronze	27
	Slide valves	Phosphor bronze	32
	Worm gears	Phosphor bronze	32
	Babbitted bearings	Lead base babbitt	49
30G	Steering Gear— (Engine same as 29G) (See also 4A)		
	Steering stands	Cast commercial brass	9
	Shafting in pilot house	Rolled manganese bronze	22
	Bevel gears	Phosphor bronze	32
	Rod stuffing boxes and glands	Screw brass	6
	Universal joints	Phosphor bronze	32
	Sheaves or sheave bushings	Phosphor bronze	33
	Screw gear operating nuts	Phosphor bronze	32
	Babbitted bearings	Lead base babbitt	49
	Tiller rope	Phosphor bronze	34
31G	Fire Main and Deck Wash System—		
	Hose connection and cap	Valve bronze	28
32G	Water Ballast and Bilge System—		
	Strainer plates	Cast naval brass	8
33G	Sanitary and Drainage Systems—		
	Brazed fittings	Brazing metal	1
	Screwed fittings	Screw brass	6
	Scupper pipes	Cast naval brass	8
	Flapper valves and clappers	Cast naval brass	8
	Pipes	Muntz metal	16
	Tubing	Admiralty metal	14
34G	Deck Pumps—		
	Casing in water cylinder	Gun metal	25
35G	Steam Heating and Steam Service—		
	Radiator fittings	Commercial brass	9 or 19
	Stuffing boxes and glands	Screw brass	6
	Radiator shields	Rolled commercial brass	19
	Pipes	Muntz metal	16
36G	Refrigerating Machinery— (See similar items of main machinery where compositions are called for)		

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	Items	Composition	Formula No.
37G	Interior Communication—		
	Rigid voice tubing	Brass	13
	Flexible voice tubing	Muntz metal	16
	Pulleys for telegraph chain	Cast commercial brass	9
	Telegraph chain	Rolled commercial brass	19
38H	Main Engine—Reciprocating—		
	Piston ring tongue piece	Gun metal	25
	Piston ring tongue piece pins	Tobin bronze	23
	Tap bolts in cylinders and valve chests for liners, etc	Tobin bronze	23
	Screws for false face on slide valves	Tobin bronze	23
	Slide valve packing ring connection pieces	Gun metal	25
	Slide valve packing ring springs	Phosphor bronze	35
	Sockets and caps for above	Gun metal	25
	Piston rod and valve stem neck and gland bushings	Journal bronze	27
	Gland studs and nuts	Rolled manganese bronze	22
	Valve stem brasses	Journal bronze	27
	Valve stem nuts	Gun metal	25
	Valve stem box distance pieces	Gun metal	25
	Valve stem box shims	Rolled commercial brass	19
	Valve stem guide boxes and yoke bushings	Journal bronze	27
	Connecting rod top and bottom end box and cap when not babbitted	Phosphor bronze	32
	Babbitted bottom end	White brass	38
	Distance pieces at both ends	Gun metal	25
	Shims at both ends	Rolled commercial brass	19
	Crosshead slippers	Tin base babbitt	44
	Crosshead slipper liners	Cast naval brass	8
	Eccentric strap bearing	Tin base babbitt	44
	Eccentric strap distance pieces	Gun metal	25
	Eccentric strap shims	Rolled commercial brass	19
	Eccentric rod brasses	Journal bronze	27
	Eccentric rod distance pieces	Gun metal	25
	Eccentric rod shims	Rolled commercial brass	19
	Link block gibs	Journal bronze	27
	Drag link brasses	Journal bronze	27
	Drag link box distance pieces	Gun metal	25
	Drag link box shims	Rolled commercial brass	19
	Valve stem guide brasses	Journal bronze	27
	Main bearings	Phosphor bronze	32
	Bearing metal for main bearings	White brass	38
	Main bearing distance pieces	Gun metal	25
	Main bearing shims	Rolled commercial brass	19
	Thrust bearings	Tin base babbitt	44
	Thrust shoes	White brass	38
	Thrust rod nuts	Manganese bronze	12 or 22
	Thrust glands	Valve bronze	28
	Thrust gland studs	Rolled manganese bronze	22
	Pipe connections for thrust circulating water	Screw brass	6
	Drain plugs for thrust shoes	Screw brass	6
39H	Reversing Engine—		
	Piston rod and valve stem gland and neck bushings	Gun metal	25
	Valve stem eye socket	Gun metal	25
	Gland nuts	Rolled naval brass	21
	Connecting rod boxes	Journal bronze	27
	Crosshead	Gun metal	25
	Guide bushings	Journal bronze	27
	Drag rod bushings	Journal bronze	27
	Shaft bearings	Tin base babbitt	44
	Link block of valve gear	Journal bronze	27
	Composition parts of handling gear, latch lever, hand wheel, clamp, etc	Brass	2
40H	Turning Engine—		
	Valve stem sleeve	Gun metal	25
	Piston rod and valve stem gland and neck bushings	Valve bronze	28
	Connecting rod brasses when not babbitted	Phosphor bronze	32
	Babbitted bottom end	Tin base babbitt	44
	Slipper babbitt metal	Lead base babbitt	49
	Crosshead brasses	Journal bronze	27
	Eccentric rods	Gun metal	25
	Eccentric strap bearing	Journal bronze	27
	Guide bracket bushings	Journal bronze	27
	Bedplate bearings	Lead base babbitt	49
	Valve gear link block	Journal bronze	27
	Worm shaft washers	Journal bronze	27
	Bearing box distance pieces generally	Gun metal	25
	Bearing box shims generally	Rolled commercial brass	19
	Hand wheel and clamp of hand lever lock	Brass	2
41H	Attached Pump Connections—		
	Rocker shaft bearing bushings	Journal bronze	27
	Pump link boxes	Journal bronze	27
	Crosshead boxes	Journal bronze	27
	Guide bracket bushings	Journal bronze	27
	Bearing box distance pieces generally	Gun metal	25
	Bearing box shims generally	Rolled commercial brass	19
42H	Throttle Valve— (See also 67S and 68S)		
	Butterfly valve	Gun metal	25
	Butterfly valve gland and neck bushing	Gun metal	25
	Hand wheel and clamp of hand lever lock	Brass	2
43H	Propelling Turbine—		
	Nozzles	Monel metal	36
	Blades	Monel metal	36
	Babbitted bearings	Tin base babbitt	44
44H	Diesel Engine—		
	Connecting rod wrist pin liners	Phosphor bronze	30
	Valves and valve seats	Monel metal	36
	Bearing metal	Tin base babbitt	41
45H	Line Shafting—		
	Bearings	Lead base babbitt	49
	Bulkhead stuffing box or neck bushing	Gun metal	25
	Bulkhead stuffing box gland or gland bushing	Valve bronze	28
46H	Propeller Shaft—		
	Shaft of salt water launches	Tobin bronze	23
	Liner or sleeve on steel shaft	Gun metal	25
	Strut bearings	Gun metal	25
47H	Stern Tube and Fittings—		
	Stern tube or after bushing	Gun metal	25
	Forward neck bushing	Gun metal	25
	Gland or gland bushing	Valve bronze	28
	Bolts to fasten gland halves	Rolled manganese bronze	22
	Gland studs	Rolled naval brass	21
	Bolts or studs fastening aft bushing to tube or tube to hull	Tobin bronze	23
	Retaining strips for lignum vitæ	Naval brass	8 or 21
	Retaining ring for ends of lignum vitæ	Cast naval brass	8
	Retaining ring studs	Tobin bronze	23
	Stern tube nut	Gun metal	25
48H	Propeller Shaft Stuffing Boxes of Small Wooden Vessels—		
	Combined bearer and stuffing box when not babbitted	Gun metal	25
	When babbitted	Cast manganese bronze	12
	Bearing metal	Tin base babbitt	44
	Bolts and lag screws	Cast manganese bronze or Tobin bronze	12 or 23
49H	Stern Bearings of Small Wooden Vessels (See 48H)		
50H	Propellers—		
	Solid propellers	Cast manganese bronze	12
	Blades and bolts	Cast manganese bronze	12
	Propeller nut and lock screw	Cast manganese bronze	12
	Propeller nut cap	Gun metal	25
	Propeller nut cap bolts or studs	Tobin bronze	23
	Propeller nut wrench eye bolts	Gun metal	25
51J	Main and Auxiliary Condenser—		
	Tube sheets	Rolled naval brass	21
	Tube supporting plates	Rolled naval brass	21
	Tubes	Admiralty metal	14
	Tube ferrules	Rolled naval brass	21
	Stay rods	Rolled naval brass	21
	Bolts and studs in salt water spaces	Tobin bronze	23
	Bolts and studs not subject to salt water	Muntz metal	16
52K	Attached Air Pumps—		
	Pump barrel	Gun metal	25
	Piston rod liner	Gun metal or naval brass	25 or 21
	Piston rod nut	Gun metal	25
	Piston rod guide brasses	Journal bronze	27
	Gland bushing	Valve bronze	28
	Gland studs	Tobin bronze	23
	Bucket follower	Gun metal	25
	Bucket key pieces	Gun metal	25
	Delivery valves	Phosphor bronze	34
	Delivery valve seats	Gun metal	25
	Delivery valve guards	Gun metal	25
	Snifting valve	Gun metal	25
	Snifting valve seat	Gun metal	25
	Bolts and studs in pump	Tobin bronze	23
	External nuts	Rolled naval brass	21
	Strainer plates	Cast naval brass	8
53K	Attached Feed and Bilge Pumps—		
	Liner	Gun metal	25
	Cast plunger	Gun metal	25
	Pipe plunger	Rolled naval brass	21
	Gland and neck bushings	Gun metal	25
	Gland studs	Rolled naval brass	21
	Bottom plug in plunger	Gun metal	25
	Valve and valve guards	Gun metal	25
	Valve seats	Gun metal	25
	Valve spindle	Tobin bronze	23
	Valve springs	Phosphor bronze	35
	Valve spring guides, bushings, spindle nuts, cap nuts and ring nuts	Gun metal	25
54K	Independent Plunger Pumps— (In general as stated for the attached pumps)		
	Piston in water cylinder	Gun metal	25
	Piston follower	Gun metal	25
	Piston rod	Tobin bronze	23
	Piston rod nut	Naval brass	21
	Liner in air or water cylinder	Gun metal	25
	Follower studs and nuts	Tobin bronze	23
	Springs	Phosphor bronze	35
55K	Centrifugal Pumps—		
	Impeller	Gun metal	25
	Wearing rings	Journal bronze	27
	Shaft	Tobin bronze	23
	Sleeve on steel shaft	Gun metal	25
	Bronze bearings	Journal bronze	27
	Babbitted bearings	Tin base babbitt	44
	Gland or bushing	Gun metal	25
	Bolts and nuts	Rolled manganese bronze	22
56K	Rotating Plunger Pumps—		
	Body or liner and plungers	Gun metal	25
	Shaft	Tobin bronze	23
	Bearings	Journal bronze	27
57L	Evaporator—		
	Tubes	Admiralty metal	14
58L	Distiller—		
	Tubes	Admiralty metal	14
59L	Feed Water Heater—		
	Header	Brazing metal	1
	Tubes	Admiralty metal	14

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	Items	Composition	Formula No.
60L	Lubricating Oil Coolers—		
	Tube plates	Rolled commercial brass.	19
	Baffle plates	Rolled commercial brass.	19
61M	Blower—		
	Bearings	Gun metal	25
62N	Tanks, etc.—		
	Tanks	Rolled commercial brass.	19
	Hinges	Hardware brass	4
	Drip pans	Rolled commercial brass.	19
	Funnels	Rolled commercial brass.	19
	Funnel nozzles	Cast commercial brass	9
63P	Boiler Fittings—		
	Safety valve disk	Monel metal	36
	Safety valve, valve seat	Monel metal	36
	Safety valve, valve seat bushing	Gun metal	25
	Safety valve spring case bushing	Gun metal	25
	Safety valve adjusting ring	Gun metal	25
	Safety valve compression screws and nuts	Gun metal	25
	Safety valve bushings in lifting gear	Gun metal	25
	Check valve body	Valve bronze	28
	Check valve disk	Valve bronze	28
	Water gage columns	Screw brass	6
	Gage cocks	Valve bronze	28
	Fusible plugs	Gun metal	25
	Salinometer cocks	Valve bronze	28
64R	Miscellaneous Connections and Fittings—		
	Expansion joint castings	Gun metal	25
	Expansion joint forgings	Rolled naval brass	21
	Cylinder relief valve and seat	Gun metal	25
	Cylinder relief valve cover nuts	Valve bronze	28
	Indicator cocks	Gun metal	25
	Drain cocks	Gun metal	25
	Pipe supports	Screw brass	6
	Wiper for crosshead guides	Rolled commercial brass	19
	Sheet metal oil boxes	Rolled commercial brass	19
	Screw fitted oil cups	Screw brass	6
	Other cast oil or grease boxes or cups	Cast commercial brass	9
	Oil strainers	Cast naval brass	8
	Cast name plates, ullage plates, etc.	Cast commercial brass	9
	Sheet name plates, etc	Rolled commercial brass.	19
	Studs for indicator gear, revolution counter, etc	Gun metal	25
	Plug cock bodies, plugs and glands	Valve bronze	28
65S	Piping—		
	Pipes	Muntz metal	16
	Thin tubing	Admiralty metal	14
	Brazed flanges	Brazing metal	1
	Screw flanges and fittings	Screw brass	6
66S	Manifolds— (See 67-68-69S)		
67S	High Pressure Superheated Steam Valves—		
	Valve disk and disk nut	Monel metal	36
	Valve seat	Monel metal	36
	Valve stem	Rolled monel metal	36
	Hand wheel	Brass	2
	Gland	Valve Bronze	28
	Gland and bonnet studs and nuts.	Rolled naval brass	21
68S	High Pressure Valves— (Except for superheated steam)		
	Body and bonnet, 4 inches and over	Gun metal	25
	Body and bonnet, 3½ inches and less	Valve bronze	28
	Valve disk, 4 inches and over	Gun metal	25
	Valve disk, 3½ inches and less	Valve bronze	28
	Valve disk nut	Valve bronze	28
	Valve seat	Gun metal	25
	Valve stem	Rolled monel metal	36
	Hand wheel	Brass	2
	Gland	Valve bronze	28
	Gland and bonnet studs and nuts.	Rolled naval brass	21
69S	Low Pressure Valves—		
	Body and bonnet	Valve bronze	28
	Valve disk and nut	Valve bronze	28
	Valve seat	Valve bronze	28
	Valve stem	Rolled naval brass	21
	Hand wheel	Brass	2
	Gland	Valve bronze	28
	Gland and bonnet studs and nuts.	Rolled naval brass	21
70T	Sea Connections—		
	Castings	Valve bronze	28
	Long bolts and inboard studs on wooden vessels	Rolled naval brass	21
	Studs and nuts exposed to sea water	Tobin bronze	23
	Strainer plates	Cast naval brass	8
	Fastenings of strainer plates	Tobin bronze	23
71V	Ash Handling Gear—		
	Ejector nozzle	Cast naval brass	8
72W	Consumable Stores—		
	Babbitt		44
	Round brass bars		19
	Sheet brass		19
	Brazing solder		50
	Soft solder		51

Reduction Gears for Ship Propulsion*

Performance of Single and Double Reduction Gears —Comparison With Other Methods of Propulsion

By Robert Warriner†

DURING the past ten years something like one thousand merchant vessels fitted with geared turbine drive have been built or are building. So rapid has this development been that most of the machinery was designed and built with scant knowledge of the real requirements for sea service and with none of the essential experience which comes from actual practice under continued service conditions. The number of gear cutting machines was also very limited and there was considerable trouble in getting special material. As a consequence there have been some unfortunate experiences which have raised doubts in the minds of many engineers as to the ultimate success of geared turbine drive. On the other hand, there are a number of examples where reduction gears are giving good service and showing better economy than reciprocating engines under the same steam conditions, and there is no doubt that by adopting a conservative design and manufacturing on sound lines this type of machinery can be made more reliable, economical and easier to handle than other kinds of steam machinery.

Lack of knowledge of gears and their requirements on the part of the engine room staff, improper lubrication, failure to keep the oil clean and free of water, especially salt water, are some of the causes of wear and complicate the task of distinguishing between the good and bad of design or material, but this is a condition which is rapidly improving and there are now plenty of engineers experienced in the handling of turbines and gearing.

Lubricating Systems Standardized

The lubricating oil systems of most of the later boats have been standardized on the lines set forth in a paper by Messrs. Smeltzer and Fernald, read before the Society in November, 1919.

The gravity system insures a constant pressure of oil to all parts of the engine, and the increased capacity of drain and gravity tanks allows for a slower circulation of the oil and provides a reserve supply which will last a few minutes after the pumps stop and allows the turbine to be safely shut down. The settling arrangements are greatly improved and the use of the DeLaval separator will do much to improve the condition of the lubricating oil.

Accuracy in Construction Essential

Accuracy in the cutting of the teeth and machining castings, assembling and setting up of parts is absolutely essential for insurance of good running. The clearance in the bearings must also be uniform so that in whatever direction the pressure is to be taken they will maintain the pinions in a true line with the wheels. The casing should be made as stiff as possible and will be better if it is so designed that

*From a paper read before the Society of Naval Architects and Marine Engineers, New York, May 26.

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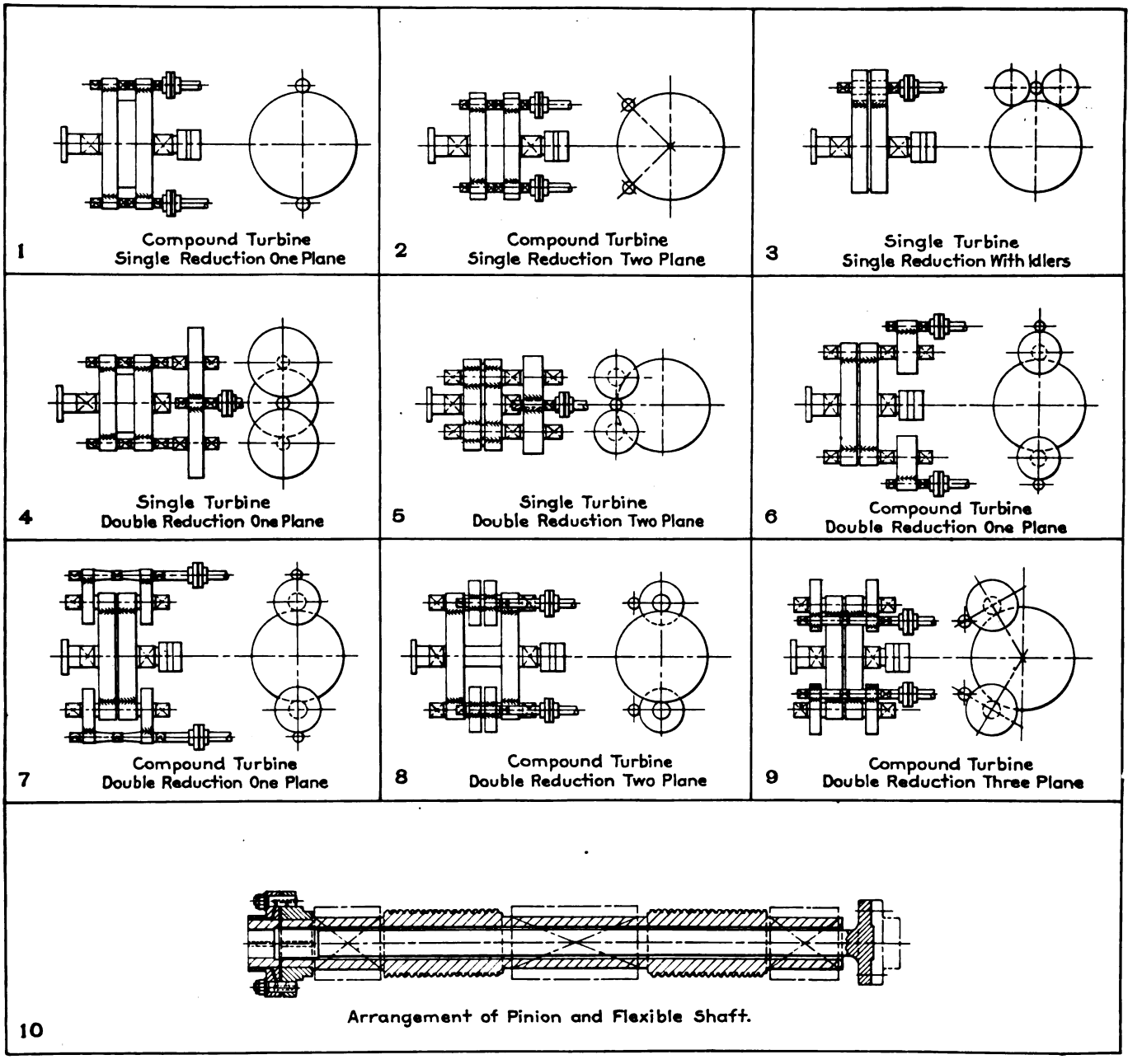

Fig. 1.—Outline Arrangements of Various Gears

it is rigid enough to hold its form when placed on the ship seatings for the process of fitting the packing blocks. The two plane and three plane types are specially advantageous in these respects as the depth is so great as compared with the area covered by the gear. Ship seatings should also be designed so that they will add to the stiffness of the casings. A ship is generally quite flexible and alters considerably with change of trim and works due to the action of the sea. It seems, therefore, desirable to make the seatings so that they will not be influenced by the movements of the ship, that is to say, they shall be substantial structures set down on the ship's bottom and free of all connections to the ship's side or bulkheads which would have the effect of transferring to the gears the movements of the ship. They should be arranged to maintain the alinement of the gears and turbines, and not, as is so often the case, to add strength to the ship's structure.

The maintenance of the contact of the pinions and wheels along the whole face is a matter of one or two thousandths of an inch and unless this alinement is strictly maintained it means that the work has to be done by only a part of the face and that the part which actually does the work is subject to increased pressure.

Undoubtedly some gears have been manufactured with tooth pressures greater than present day materials and manufacture will stand. Devices for giving flexibility and to compensate for misalinement have been tried out in the test house and have shown the capacity of gearing to work under loads far in excess of those used in service. These tests would be carried out under the best conditions with little to distort the casings or to upset the alinement. The conditions at sea, however, are entirely different and it is difficult to estimate what may have to be taken into account. Apart from the alteration in a ship's structure due to loading or trim and running light there is the occasional disturbance due to heavy weather, the effect of which cannot be calculated.

Tables *I* and *II* show the principal dimensions of gears by different makers. These are by no means complete but are representative of what has so far been made. Fig. 1 shows diagrammatically the arrangement of wheels and pinions for a variety of reduction gears and is explanatory of some of the terms used in the paper.

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TABLE I.—DOUBLE REDUCTION GEAR DATA

Reduction gear number..	1				2				3				4			
Horsepower of ship and number of screws.....	1,500 Single Screw				2,800 Single Screw				3,100 Single Screw				4,500 Twin Screw			
Horsepower transmitted by each gear.....	1,500				2,800				3,100				2,250			
Horsepower transmitted by h.p. pinion.....	1,500				1,400				1,550				2,250			
R. p. m.	3,600-90				3,566-90				3,196-90				3,300-105			
Type of gear.....	One Plane				Three Plane				Three Plane				One Plane			
Element	High Speed		Low Speed		High Speed		Low Speed		High Speed		Low Speed		High Speed		Low Speed	
Part	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear
Number	1	1	1	1	2	2	2	1	2	2	2	1	1	2	2	1
R. p. m.	3,600	578	578	90	3,566	539	539	90	3,196	538	538	90	3,300	444	444	105
Pitch diameter (D).....	85.00"	53.000"	12.400"	79.600"	7.75"	51.250"	15.613"	93.387"	8.500"	50.500"	15.629"	93.371"	7.60"	52.00"	11.274"	17.786"
Number of teeth.....	34	212	31	199	31	205	31	187	34	202	39	233	40	297	30	127
Diametral pitch	4.0		2.5		4		1.99		4		2.50		5.71		2.66	
Normal diametral pitch..	5.65		3.53		5.65		2.16		5.65		2.71		8.02		3.00	
Helix angle	44° 53' 30"		44° 53' 30"		44° 53' 30"		22° 58' 18"		44° 53' 30"		22° 58' 30"		44° 26'		27° 30'	
Pressure angle	26° 56' 30"		26° 56' 30"		26° 56' 30"		20°		26° 56' 30"		25°		20°		20°	
Effective width of face..	15"		36"		14"		26"		16"		27.5"		20"		40"	
Velocity of pitch line per second	133.5		31.2		121		36.7		118.5		36.6		100.9		21.9	
Tangential tooth per lb. per inch of face (P.)..	412		733		455		808		450		345		307		706	
K (P_2KVD)	141		208		163		204		154		214		116		210	
Length of helix per dia. of pinion	1.76		1.45		1.81		.832		1.88		.880		1.03		1.77	
Stress at base of teeth, lbs. per square inch...	3,260	2,775	3,780	2,525	3,680	2,500	3,840	2,860	3,565	2,472	4,220	3,160	5,100	4,220	4,400	3,520
Weight per gear in pounds	.....		.....		.....		.....		.....		.....		100,000			
Turbine	Single				Compound				Compound				Single			
Gear maker	Falk Co.				Falk Co.				Falk Co.				Bethlehem Corp.			

TABLE I.—DOUBLE REDUCTION GEAR DATA (CONTINUED)

Reduction gear number..	5				6				7				8			
Horsepower of ship and number of screws.....	2,500 Single Screw				2,400 Single Screw				4,000 Single Screw				3,000 Single Screw			
Horsepower transmitted by each gear.....	2,500				2,400				4,000				3,000			
Horsepower transmitted by h.p. pinion.....	2,500				2,400				4,000				1,500			
R. p. m.	3,480-90				3,302-75				3,480-90				3,360-90			
Type of gear.....	One Plane				Two Plane				One Plane				.....			
Element	High Speed		Low Speed		High Speed		Low Speed		High Speed		Low Speed		High Speed		Low Speed	
Part	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear
Number	1	2	2	1	1	2	2	1	1	2	2	1	2	2	2	1
R. p. m.	3,480	463	463	90	3,302	657	657	75	3,480	458	458	90	3,360	585	585	90
Pitch diameter (D).....	7.4"	55.6"	10.25"	52.75"	6.5"	32.667"	11.000"	96.333"	7.612"	57.888"	10.75"	54.75"	5.196"	29.830"	9.238"	60.045"
Number of teeth.....	37	278	41	211	39	196	33	289	38	289	43	219	27	155	28	182
Diametral pitch	5		4		6		3		5		4		5.2		3.03	
Normal diametral pitch..	7.07		4.33		6.73		3.26		6.11		4.35		6		3.5	
Helix angle	45°		23°		27°		22° 58'		35°		23°		30°		30°	
Pressure angle	15°		15°		22° 13'		21° 32'		23° 57'		16° 14'		16° 38'		16° 38'	
Effective width of face..	18"		45"		18 4"		32"		19.6"		48"		20"		36"	
Velocity of pitch line per second	112		20.7		93.7		31.6		115.7		21.5		76.2		23.6	
Tangential tooth per lb. per inch of face (P.)..	340		740		382		652		486		1,065		541		972	
K (P_2KVD)	125		231		150		196.5		176		325.5		237		320	
Length of helix per dia. of pinion	2.44		2.20		1.415		1.455		1.29		2.23		1.93		1.95	
Stress at base of teeth, lbs. per square inch...	...	...	...	...	4,370	...	3,500	...	4,000	...	6,750	...	10,500	8,300	11,000	8,500
Weight per gear in pounds	75,000				77,000				124,000				63,800			
Turbine	Single				Single				Single				Compound			
Gear maker	De Laval Co.				General Electric Co.				General Electric Co.				Westinghouse Co.			

TABLE II.—SINGLE REDUCTION GEAR DATA

Reduction gear number..	9		10		11		12		13		14			15		16	
Horsepower of ship and number of screws.....	9,000 Twin Screw		5,000 Twin Screw		4,500 Twin Screw		10,000 Twin Screw		12,000 Twin Screw		28,000 Twin Screw			90,000 Quadruple Screw		27,000 Twin Screw	
Horsepower transmitted by each gear.....	4,500		2,500		2,250		5,000		6,000		14,000			22,500		13,500	
Horsepower transmitted by h.p. pinion.....	2,250		1,250		1,125		2,500		3,000		7,000			11,250		6,750	
R. p. m.	1,500-120		2,204-110		1,924-105		1,793-125		1,789-125		3,217 and 2,994-450			2,513-400		2,950-455	
Type of gear.....	One Plane		One Plane		Two Plane		One Plane		One Plane		One Plane			One Plane		.....	
Part	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	Pinion	Gear	H. S. Pinion	L. S. Pinion	Gear	Pinion	Gear	Pinion	Gear
Number	2	1	2	1	2	1	2	1	2	1	1	1	1	2	1	2	1
Pitch Diameter (D).....	8.50"	106.75"	6.000"	120.240"	7.143"	130.857"	9.143"	131.143"	10.0"	143.143"	10.800"	11.600"	77.200"	13.429"	84.286"	10.227"	66.314"
Number of teeth.....	34	427	25	501	25	458	32	459	35	501	27	29	193	47	295	31	201
Diametral pitch	4		4.167		3.5		3.5		3.5		2.5			3.5		3.03	
Normal diametral pitch..	5.65		5.00		4.04		4.95		4.95		3.54			4.04		3.5	
Helix angle	45°		33° 33' 26"		30° 2' 54"		44° 53' 30"		44° 53' 30"		44° 53' 30"			30° 2' 54"		30°	
Pressure angle	15°		20°		25°		26° 56' 30"		26° 56' 30"		25°			25°		16° 38'	
Effective width of face..	48"		24"		22"		36"		38"		33"			48"		26"	
Velocity of pitch line per second	55.5		57.8		60.0		71.7		78.2		151.5			147.2		131.5	
Tangential tooth per lb. per inch of face (P.)..	463		496		469		532		555		770			857		1,080	
K (P_2KVD)	159		202		175		176		175		234	226		239		328	
Length of helix per dia. of pinion	2.83		2.00		1.54		1.97		1.90		1.53	1.42		1.79		1.27	
Stress at base of teeth, lbs. per square inch...			5,630	3,960	3,960	2,770	3,610	2,555	3,780	2,660	6,010	5,920	4,125	4,300	3,855	11,750	9,100
Weight per gear in pounds	76,000		60,000		.....		.....		.....		38,400			.....		21,200	
Turbine	Compound		Compound		Compound		Compound		Compound		Compound			Compound		Compound	
Gear maker	De Laval Co.		Bethlehem Corp.		Falk Co.		Falk Co.		Falk Co.		Falk Co.			Falk Co.		Westingh'se Co.	

Few Failures with Single Reduction Gears

The single reduction sets are generally satisfactory and out of the large number fitted there have been very few failures. The tooth pressures are not excessive, those for war vessels may be fairly high but they have only to work at full power occasionally and for very short periods. The turbine speeds are usually moderate and the inertia of the

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moving parts correspondingly low. It is easy to estimate the load on each pinion due to the turbine and the difference between mean and maximum torque is much smaller than in the case of double reductions with their high speed turbines. In the latter (Nos. 4 and 5, Fig. 1) where a single turbine is used to drive two sets of wheels and pinions, it is difficult to assemble them so that work is divided evenly between the two sets, and any uneven wear or adjustment of the bearings will throw most of the load on one side or the other with an increase of the tooth pressure on that side.

Some of these gears are also solidly coupled together so that there is no give in the gears themselves to compensate for this uneven loading.

The single reduction gears under column No. 9 of Table II have given considerable service. They were installed on the *Orizaba* and *Sibboney* and were manufactured by the DeLaval Company. Both of these vessels were operated under very severe overload conditions during the war. The *Orizaba* has steamed, to date, over 225,000 miles and the *Sibboney* 175,000 miles. It is stated that when the gears were last examined they were in excellent condition. All the other gears of this sort, tabulated, are, so far as can be learned, operating well, though the mileage is much less than in the case of the two ships quoted.

Among the double reduction gears there are some cases of extended running which point to the loads which gearing will stand safely. The S. S. *Pacific* in service since December, 1915, still has the original low speed gears, which, on last report, had made 240,000 miles. The S. S. *Sucrosa* in service since July, 1916, also has the original low speed gears after running 225,000 miles. The high speed train was renewed after 120,000 miles. The S. S. *Mielero* had the original gears still in use after three years' running during which she made 160,000 miles. These are all of the two plane type (No. 5, Fig. 1) and were made by the General Electric Company.

The design tabulated in column 1, Table I, has given an excellent account of itself and there have been no breakdowns or repairs. Some of these units have been in service over two years and show little sign of wear. Those tabulated under column 3, Table I, have also given excellent service. Both of these are Falk gears.

In regard to double reduction gears of the single plane type the results are various but there are few which have seen 100,000 miles of sea service, and this type is not likely to be repeated, to any great extent.

MAXIMUM SAFE TOOTH PRESSURES

After studying the results obtained on various types the author suggests the following table of tooth pressures as being the maximum which it is safe to use:

$$K = \frac{P}{\sqrt{D}}$$

P = Pressure per inch of working face
D = Diameter of pinion in inches

		K	D
Double reduction gear with a single turbine where a single pinion meshes with two high speed wheels coupled to two low speed pinions driving one low speed wheel	High speed	120	6″ to 9″
	Low speed	180	9″ to 16″
Double reduction gear, single or compound, where each turbine drives a single wheel and pinion	High speed	150	6″ to 9″
	Low speed	220	9″ to 16″
Single reduction gears, constant service	.....	175	
Single reduction gears where full power is only used occasionally	.....	250	

One further important item is the length of helix in proportion to the diameter of the pinion, and the constants quoted are based on the assumption that this ratio does not exceed 2 to 1 and should be reduced to 1.5 to 1 whenever possible.

Considerable difference has been found in the life of gears of the same design, between those fitted amidships and those fitted in the stern of the ship, the latter wearing more rapidly. The inertia of the turbine is much greater than that of the propeller and shafting and the turbine will run with practically uniform angular velocity while the motion of the propeller will be uneven due to the different conditions of water, depths, etc. This variation will have little effect on the gears when transferred through the long flexible shaft of the machinery fitted amidships, but with the short shaft for those fitted in the stern of the vessel this variation of torque will be reflected on the teeth without any damping due to the shaft. When reduction machinery is fitted in the after end of the ship it is better to fit the turbines aft of the gears so as to make the line shaft as long as possible.

HIGH DEGREE SUPERHEAT WOULD INCREASE EFFICIENCY

The superheater has, so far, not found much favor in America for marine purposes, and considering the number of turbine driven vessels that are being built it is surprising that so many are working without superheat. The turbine under the same steam conditions gives an efficiency of 10 to 15 percent better than the reciprocating engine. From the actual service results of three steamers of the same capacity and in the same trade and running 55,000 miles a year, the one with triple expansion engines used 335.3 pounds of oil per knot and the other two with turbine machinery used 281.5 pounds and 282.5 pounds of oil, respectively. This could have been improved considerably by the use of superheat with very little increase in the cost of the turbines. Practically all that would have been needed would be to make the high pressure end of the casing of cast steel instead of cast iron.

TABLE III

	Reciprocating	Turbine	Diesel	Electric Drive
Speed of ship, knots	11.5	11.5	11.5	11.5
Diameter of propellers	17′ 6″	15′ 8″	15′ 8″	15′ 8″
Revolutions per minute	76	105	105	105
S. H. P. for 250 sea miles per day	4135	4350	4350	4350
S. H. P. maximum	4600	5800	5000	5800
Weight of machinery and water, tons	1060	914	1267	981
Weight of machinery in lbs. per max. S. H. P.	517	353	567	379
Space occupied by machinery, cubic feet	171,826	171,826	192,251	171,826
Total weight of hull and machinery, tons	9350	9200	9700	9267
Net carrying capacity of ship bunkered for 20 days' steaming and 8 days' reserve fuel, tons	18,775	19,220	19,482	19,153
Comparative cost of machinery	100	98.3	123.5	128.3
Fuel consumption per day 250 sea miles, tons	60	48	24	48
Estimated cost of operating per day*				
Crew	13.33	13.33	14.46	13.33
Repairs	11.34	11.34	11.34	11.34
Stores	4.82	4.82	7.89	4.82
Provisions	3.97	3.97	4.26	3.97
Depreciation	27.10	27.00	29.83	30.10
Insurance	17.60	17.53	19.40	19.67
General	1.42	1.42	1.42	1.42
Fuel oil	20.42	16.34	8.18	16.34
Total	100.00	95.74	96.38	100.99
Per deadweight ton	100.00	95.74	96.38	100.99

* Based on total of 100 for reciprocating machinery.

There is shown in Table III a comparison of machinery for 20,000 deadweight tons combined ore and oil vessels, showing the relation as to the weight, space, cost and operating expense for reciprocating engines, turbines and reduction gears, Diesel and electric drive on these particular vessels. In this the Diesel engine is rather at a disadvantage owing to the necessity of fitting considerable boiler power for heating the cargo oil. All the sets are twin screw.

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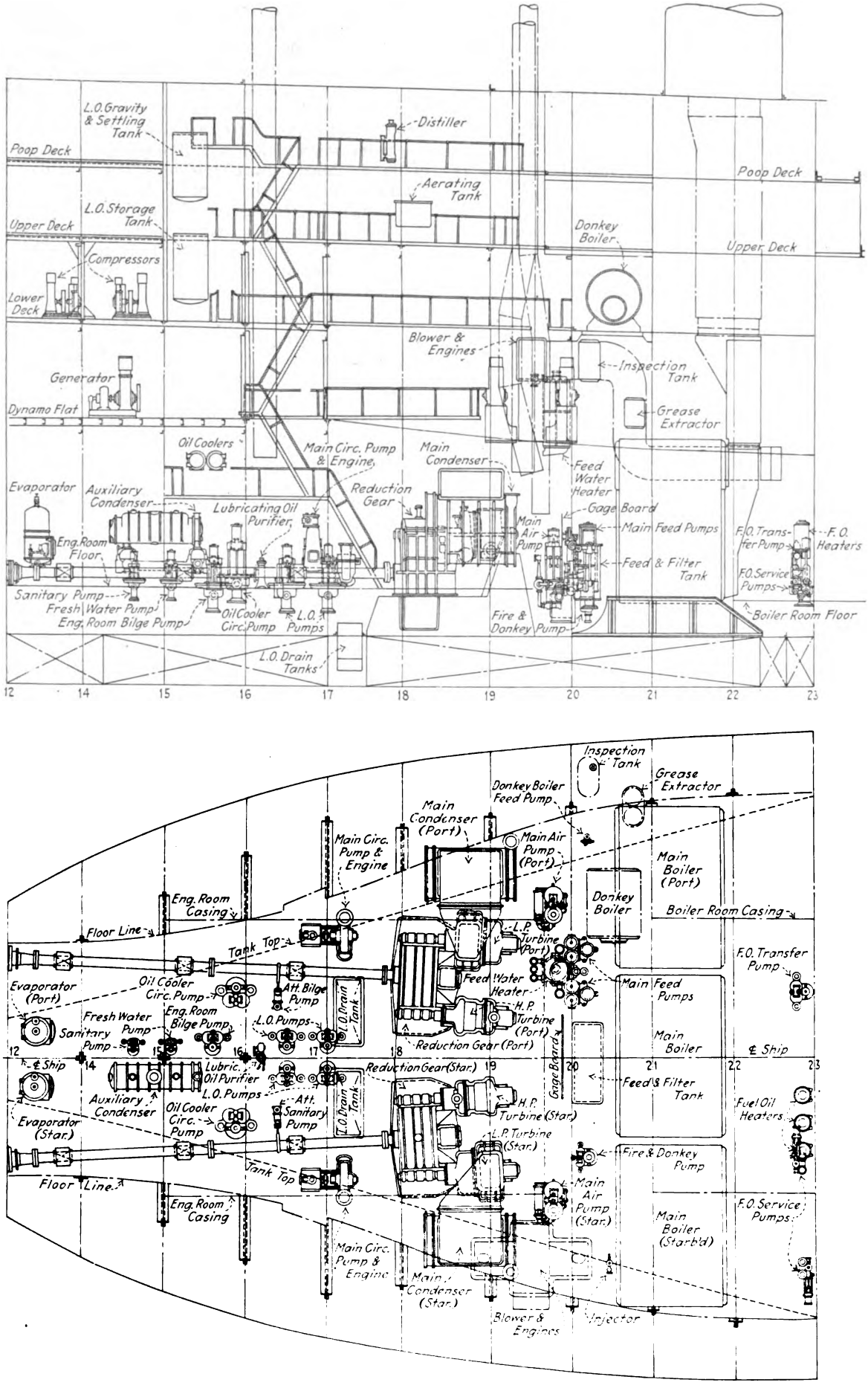

Fig. 2.—Arrangement of Twin Screw Geared Turbine Machinery of 5,000 Shaft Horsepower

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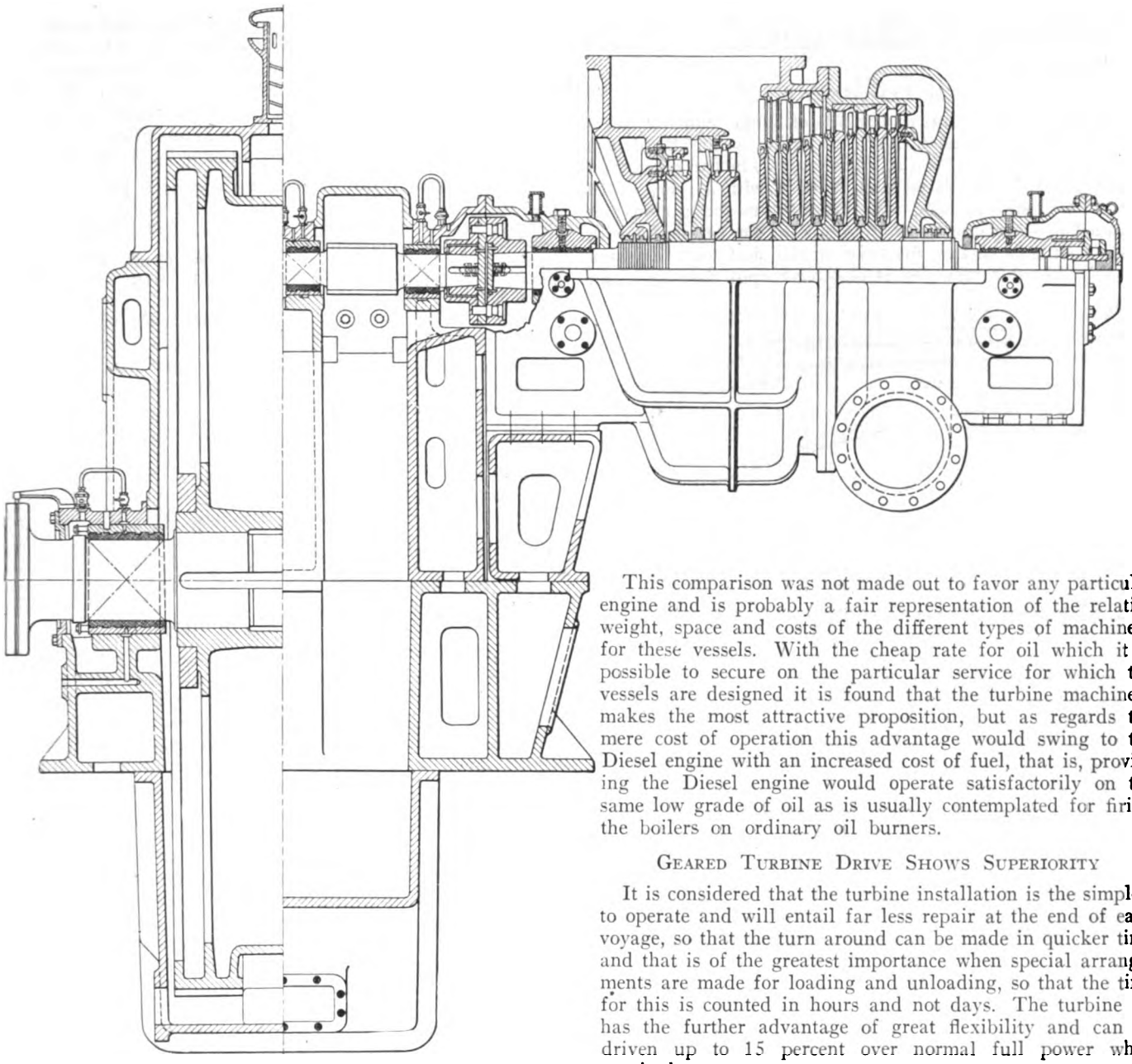

Fig. 3.—Section Through 2,500 Shaft Horsepower Compound Curtis Turbine and Falk Single Reduction Gears

The reciprocating engines are triple expansion with cylinders 25 inches, 41 inches and 68 inches diameter by 48 inches stroke and there are three cylindrical boilers 17 feet 6 inches diameter by 12 feet long, operated at 190 pounds per square inch and 20 degrees superheat, oil fired and with heated air forced draft.

The turbine machinery is cross compound with single reduction gears, turbine revolutions 1,930 per minute to 105 at the propellers. The boilers are the same size as for the reciprocating set and arranged for 220 pounds per square inch working pressure and 200 degrees F. superheat. The water rate for the turbines will be 9.6 pounds per shaft horsepower per hour.

The Diesel machinery consists of two engines, each with six cylinders 25½ inches diameter by 48-inch stroke, two cycle. In this ship all the main and auxiliary deck machinery is driven electrically.

The electric drive consists of one turbo-generator with an auxiliary generator to give a speed of about six knots, and two large motors, one on each propeller shaft. The boilers are the same as for the turbine drive.

This comparison was not made out to favor any particular engine and is probably a fair representation of the relative weight, space and costs of the different types of machinery for these vessels. With the cheap rate for oil which it is possible to secure on the particular service for which the vessels are designed it is found that the turbine machinery makes the most attractive proposition, but as regards the mere cost of operation this advantage would swing to the Diesel engine with an increased cost of fuel, that is, providing the Diesel engine would operate satisfactorily on the same low grade of oil as is usually contemplated for firing the boilers on ordinary oil burners.

GEARED TURBINE DRIVE SHOWS SUPERIORITY

It is considered that the turbine installation is the simplest to operate and will entail far less repair at the end of each voyage, so that the turn around can be made in quicker time and that is of the greatest importance when special arrangements are made for loading and unloading, so that the time for this is counted in hours and not days. The turbine set has the further advantage of great flexibility and can be driven up to 15 percent over normal full power when required.

It is interesting to note that the cost of the turbine installation is somewhat less than that of the reciprocating machinery, and if the boilers had been reduced to the extent warranted by the decreased steam consumption of the turbine, there would have been a still further reduction in weight and cost. It was, however, considered to be an advantage to have the boilers operating under easier conditions for the normal full power and to have available, when required, the extra power and speed.

The arrangement of the turbine machinery is shown on Fig. 2 and of the turbine and gears on Fig. 3.

When comparing the efficiency of turbines and reciprocating engines it is usual to consider the best steam consumption of both. The turbine having good clearances and no wear on the parts affecting economy should maintain its efficiency, but the reciprocating engine falls off rapidly, due to the wear on valves and piston rings, liners and cylinders.

The question of gear efficiency has been much debated and various factors have been given from time to time. The Falk Company devised a means of testing them under full load, for bearings and teeth, with a motor large enough to supply the amount lost in friction only. This was further extended so that they could be tested for efficiency and tests

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were subsequently made on a number of gears, the results of which the Falk Company have kindly allowed me to add to this paper.

TESTS FOR EFFICIENCY OF GEARS

The first of these was on two sets of single reduction gears for one of the 35-knot destroyers built by the Bethlehem Shipbuilding Corporation at Fore River. The two gears, port and starboard, are placed back to back with a space of 10 or 12 feet between them. The main shafts and pinions are coupled together, the latter by means of torsion shafts with large couplings so that the twist on the shaft can be varied at will. By this means it is possible to put the same load

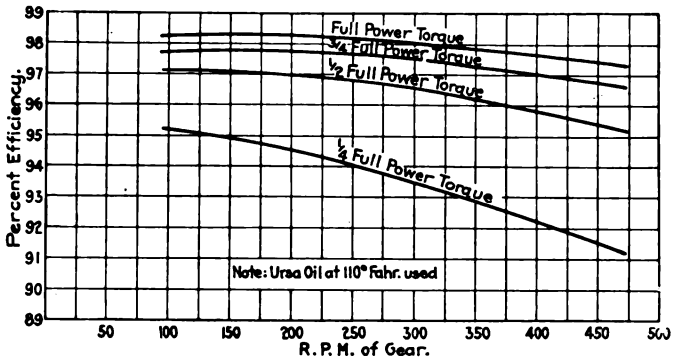

Full Power Torque
¾ Full Power Torque
½ Full Power Torque
¼ Full Power Torque
Note: Ursa Oil at 110° Fahr. used
Percent Efficiency.
R. P. M. of Gear.

Fig. 4.—Efficiency Curves from Tests on 14,000 Shaft Horsepower Geared Unit

on the bearings and to run the gears at the same tooth pressures and under the same conditions as when operating on board ship. The two sets are driven by a direct current motor at the required speed and the power developed by the motor represents the friction of all the gears and bearings in the two units. The thrusts are not loaded but these are not a part of the gears and as they are only located in the casing for convenience of manufacture they should not be included in the gear losses. The results are corrected for motor effi-

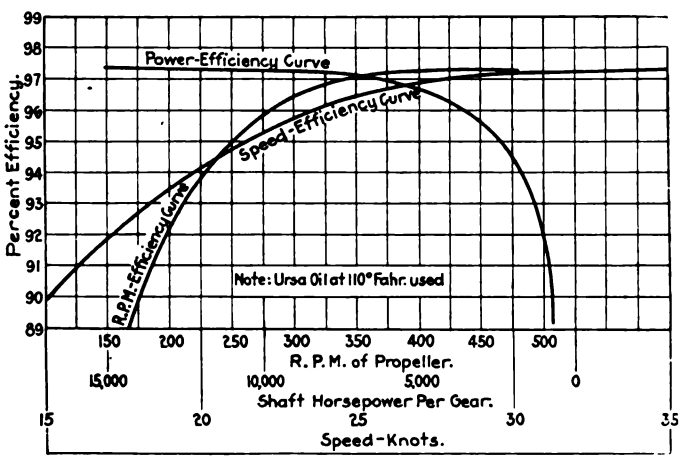


Fig. 5.—Efficiency Against Actual Speed Characteristics of Ship

ciency. The oil service and lubrication are the same as for actual service.

In the case of the destroyer gears a number of tests were run with various loads and speeds so as to obtain a curve for the efficiency over a range of speeds and powers. The curves for the actual tests are shown for one-quarter, one-half, three-quarters and full power torque, each over a range of speeds (see Fig. 4) and from these further curves have been developed showing the efficiency at various speeds, powers and revolutions at which the machinery would work in the ship, Fig. 5. It will be seen that the maximum efficiency is 98.3 percent at full torque and about one-half speed. In a ship, however, this condition is not used and the maximum efficiency is only 97.3 percent. The bearings of these sets are very ample and account for the major part of the friction loss. Further experiments were made with shortened bearings and showed a gain in efficiency, but the curves are given for the actual gears as installed.

A summary of other tests is contained in Table IV.

TABLE IV.—RESULTS OF REDUCTION GEAR TESTS

Test No.	2	3	4	5
Duration of test	21 hrs.	14 hrs.	11 days	8 hrs.
Total horsepower output of two gear units	12000	12000	6000	6200
Horsepower delivered by each pinion	3000	3000	1500	1550
Tooth pressure, lbs. per in. of face—H. S.	630	553	482	448
Tooth pressure, lbs. per in. of face—L. S.	....	....	862	842
Inlet temperature of water to oil cooler, deg. F.	67.0	59.5	51.7	54.0
Outlet temperature of water from oil cooler, deg. F.	82.2	75.1	72.4	67.9
Pounds of water per min. to cooler	424	442	312	386
Horsepower absorbed by cooling water	152	168	151	126
Temperature of oil to unit, deg. F.	125	110.5	103	118.5
Temperature of oil from unit, deg. F.	131	120.5	....	124
Pressure of oil to gears	18.4	8.9	12.0	11.7
Revolutions per min. of propeller shaft	125	125	90	90
Horsepower loss in units	229	209	203	186
Output plus losses of gear units	12229	12209	6203	6386
Gear unit efficiency	.981	.983	.968	.973

Test No. 2 was made on units of single reduction gears for the passenger ships for the United States Shipping Board. These units were designed for a normal horsepower of 10,000 but the test was made at 12,000 shaft horsepower as shown with a gear efficiency of 98.1 percent.

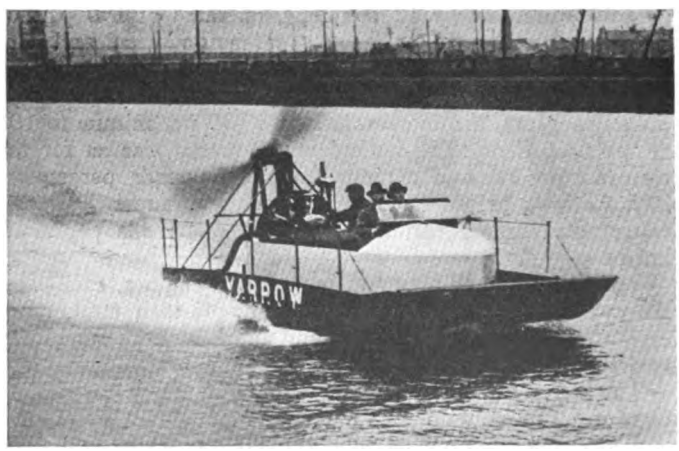
No. 3 was made on units for passenger ships similar to No. 2, but designed for 12,000 shaft horsepower. These were made at a later date and the improvement is shown by the increased efficiency.

The fourth test was made on a pair of double reduction gears with compound turbines and was carried on continuously for eleven days. The conditions were maintained very nearly constant and the efficiency, 96.8 percent, is very good for this type of machine.

Column No. 5 is for a similar set of gears with improved bearings, an arrangement which resulted in increasing the efficiency to 97.3 percent.

A New Type of Shallow Draft Vessel

CONSIDERABLE interest is being shown in the skimming boat which Messrs. Yarrow & Company, of Glasgow, Scotland, are running on the Clyde, both river and firth, and which is propelled by an aeroplane type petrol engine and air propeller. The hull is of the hydroplane type.



The Yarrow Skimming Boat at a Speed of 50 Miles Per Hour

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Superheated Steam on Steamships

Comparison with Locomotive and Shore Practice—Results with Reciprocating Engines and Scotch Boilers

By C. H. Peabody, Dr. Eng.

THE advantages of the use of superheated steam have long been known in America and in particular as applied on steamers. In 1863 Chief Engineer B. F. Isherwood, U. S. N., made exhaustive tests on the U. S. S. *Eutaw* and put the whole matter on a scientific basis pointing out the precautions that must be taken to insure reliable results and the proper way of reporting gains in terms of coal used per horsepower per hour. Those were the days of simple engines, small powers and low pressures. Any proper method of saving fuel was bound to give notable results; his experiments showed a gain of eighteen percent from the use of superheated steam.

Following Isherwood's investigations, superheated steam was used in both the American and the British navies with decided advantage so long as the superheaters were in condition. The last sentence gives half the answer to the question why superheating, having repeatedly shown notable advantage in economy, nevertheless has fallen into disuse and under prejudice with some engineers; the other half of the answer is that in the earlier days of steam engineering other methods of improving economy found favor, such as compounding and steam jacketing.

Again and again, superheating has fallen into disfavor because the superheater has burned out and leaked. In later years greater knowledge of metallurgy and new methods of construction have met this difficulty so that today superheaters showing long and satisfactory service are found on shipboard, in the British, French and German merchant marines. Now that the United States is striving for its place in the ocean carrying trade it is necessary that intelligent attention should be given to the use of superheated steam.

It is notable that superheated steam finds favor today in America at the extremes; with the most economical and with the most wasteful of steam motors; namely, for steam turbines and for locomotive engines.

Superheated Steam on Locomotives

The use of superheated steam on locomotives is particularly interesting for our present purpose, because the locomotive has some of the restrictions of the marine engine in an exaggerated form and because the form of superheater which has given satisfaction on the locomotive is now widely used for ships. It will be recalled that about twenty-five years ago compound locomotives were introduced and found considerable favor. Two reasons led to this, first a desire to save coal and second to get more work out of a given locomotive boiler; and the second was the controlling motive. Coal may cost money, but in any case the train must be taken over the road. And trains continually grow heavier.

The attitude of the railway man is shown by the tests made of superheating by the Pennsylvania railroad. They selected the summer train from Camden, N. J., to Atlantic City. Using the old type of locomotive with saturated steam they began with a train of seven cars to determine the maximum weight of train that could make the run on time. One by one cars were added till there were ten in the train and still the locomotive could make the run on time. One more car, making eleven in all, was just too much and the locomotive failed to make time. Taking the same engine with a superheater added they began with eight cars and, as before, added one car after another until there were fourteen cars on the train and yet the locomotive could make the run on time. Fifteen cars were found to be too many; thus the comparison showed that the superheater had an advantage in the ratio of 14 to 10. Incidentally the locomotive with superheater burned a little less coal when dragging 14 cars than the other engine dragging 10 cars.

It should be remembered that the locomotive has a single unjacketed non-condensing engine and with a moderate ratio of expansion. Such an engine has but a poor economy due in large measure to cylinder condensation. Superheated steam acts directly and effectively to reduce cylinder condensation and superheating of itself tends toward better economy. But there is on the locomotive another and a most important advantage from the use of the superheater in that it adds heating surface which the locomotive sadly needs, and again the gases from the boilers are so hot that they can do the superheating without calling for more coal.

It is therefore no wonder, now that a practical superheater is found, that at the present moment half the locomotives in the United States have superheaters. It is to be expected that, in the near future, practically all locomotives will be provided with superheaters.

Let us pause to consider why the compound locomotive after having won a favorable place has so far lost it that but few are found in service and fewer are likely to be built. The first and controlling reason is that a locomotive must be simple and certain in action and must be able to pick up its train smoothly and quickly. The locomotive engineers did not like the compound type and in this case we must admit that the practical man had reason for his prejudice.

Superheated Steam in Power Plants Ashore

Having considered one extreme of our subject, namely, the locomotive, let us take the other, that is to say the steam turbine as used in a modern electric power station. Here every means of improving economy may be found. The boiler has ample heating surface and the hot gases are passed through an economizer so that they may have only enough temperature left to work the chimney. Under such condition, as pointed out by Isherwood, fuel must be burned to superheat the steam; and under just such conditions the turbine engineer claims that the advantage of superheating is more than thermodynamics would indicate. The turbine engineer has found that superheating reduces the blade resistance of the turbine and so indirectly as well as directly adds to the economy. This is worth consideration now that turbine propulsion bulks so large in marine engineering.

But the question is now the application of superheating to the reciprocating marine engine. Though the concentration of power on shipboard long ago outstripped land power stations and though the economy of coal has always been of vital importance, the marine engine never has been in the same class with high class land engines like those at pumping stations. There are two controlling reasons for this defect; the boilers must avoid undue weight and the engines must be simple mechanically and certain in action. The boilers never have as much heating surface as the engineer would like and the valve gears are directly moved by link motions. Even though triple expansion engines are habitual for seagoing ships the expansion is insufficient and there is little gain from high vacuua. Large engines are commonly fitted with cylinder liners and the jackets on the

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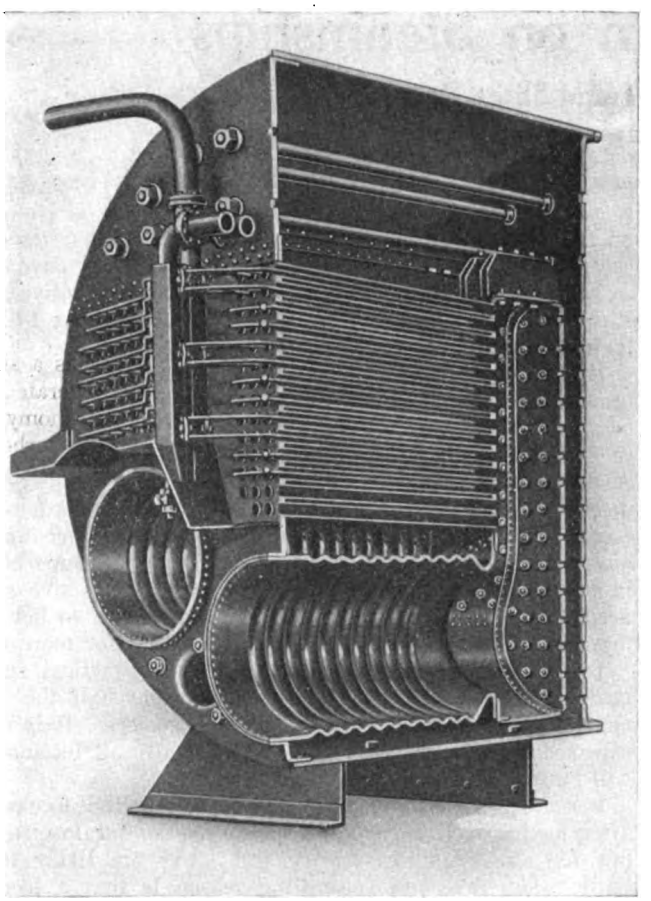

Fig. 1.—Sectional View of Scotch Boiler, Showing Location of Superheater Elements in Fire Tubes

barrels are used for warming up the engine, but too often are either shut off or ineffective at sea. The marine engine, though subject to its limitations, is in much better care than the locomotive engine and the gain from superheating cannot be expected to be so large; but under some cases the gain may be very important and the subject is worthy of consideration for all ships.

Having opened the subject, this article will be limited to describing one type of superheater and the presentation of one clear case of the advantage from superheating.

SUPERHEATERS FOR SCOTCH BOILERS

The form of superheater here presented is that made by the Superheater Company, New York, and adapted to use with Scotch boilers; this form of superheater is interesting because of its extensive use on locomotives where conditions are at least as strenuous as on any steamship.

The application of this type of superheater to a Scotch boiler with three furnaces is shown by Figs. 1 and 2. The steam pipe leading from the dry pipe (Figs. 1 and 2) is shown entering the uptake at the left of Fig. 1; the main then branches inside the uptake and connects with the saturated steam headers as shown more clearly in Fig. 2. From the saturated header a superheater unit or units are carried for each horizontal row of fire tubes of a wing furnace; the middle furnace is supplied alternately from one header or the other. The unit, which is a continuous flat coil of pipe, after serving the several tubes in its row is connected to the superheated header as shown in Fig. 2. From the superheated headers, pipes lead out of the uptake and to the steam main. Certain rows of the boiler fire-tubes are left vacant as a matter of convenience.

The superheating units are made by forging the ends of a straight section into a return bend, whose thickness is somewhat greater than the thickness of the tube, as shown by Fig. 3. By this form of construction each unit consists of a single continuous pipe without screwed joints or connections.

Each unit is connected to the saturated header at one end of the flat coil, and to the superheated header at the other end, by a recessed joint shown in Fig. 4. The collar on the unit pipe is expanded and recessed, and by means of an open end clamp engaging two unit ends, is held in

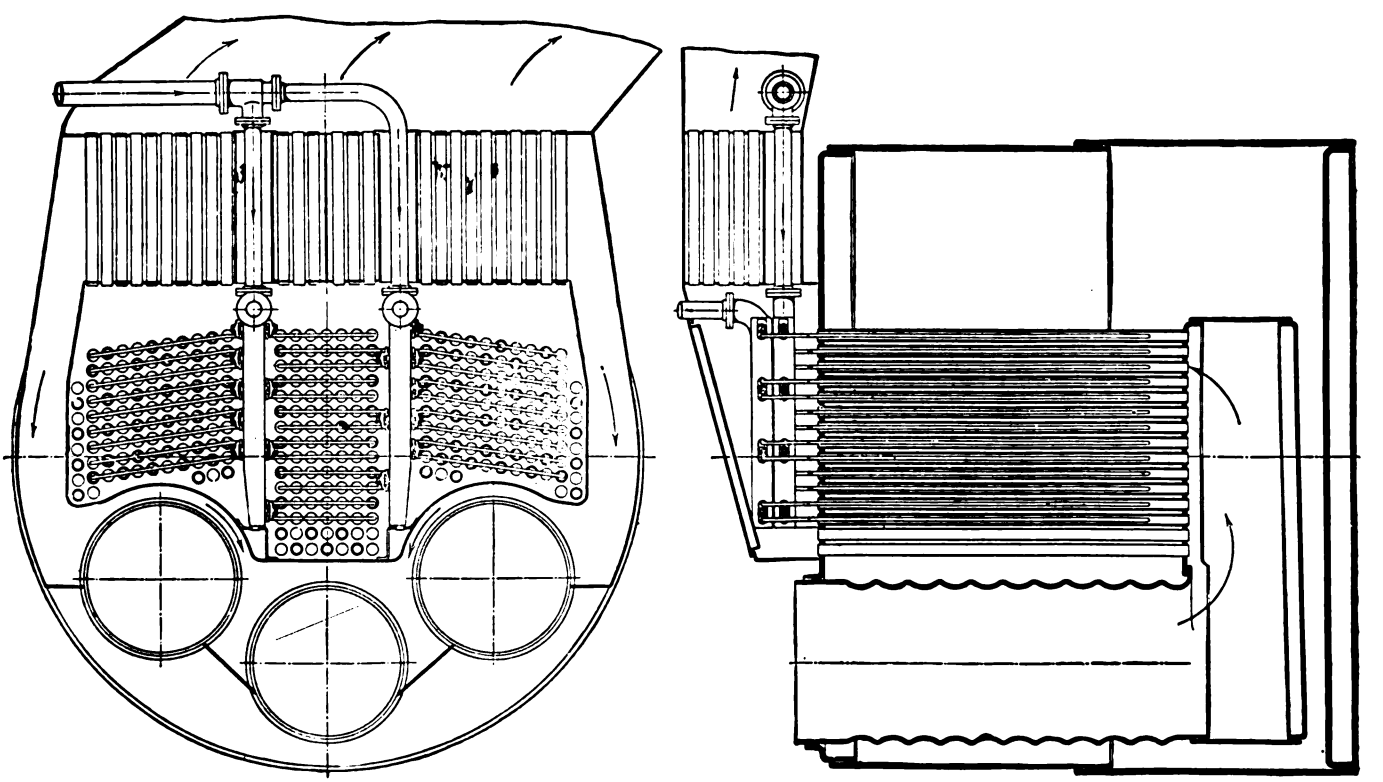

Fig. 2.—Fire Tube Superheater in Scotch Boiler Showing Steam Piping to and from the Superheater as Well as Air Preheater Located in the Uptake

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place. One stud holds one clamp. A gasket of metal and asbestos forms the joint between the collar and the recessed seat of the header. Any unit can be removed without disturbing other units, or necessitating dismantling any part of the boiler. The headers are made of either steel, or semi-steel, and meet the requirements of all classification societies.

ENGINE VALVES AND FITTINGS FOR SUPERHEATED STEAM

An engine using superheated steam should have piston valves; at any rate the high pressure valve must be a piston valve. Suitable metallic packing must be used on the high pressure piston rod and valve stem. Also a proper high flash mineral oil must be used for cylinder lubrication. Proper oil for this purpose can readily be obtained on the market.

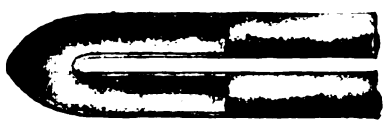


Fig. 3.—Sectional View of Continuous Return Bend of Superheater Element

The cleaning of both the superheater units and of the boiler firetubes is done effectively by aid of superheated steam jets provided for the purpose.

When superheated steam is used the pipe lines and fittings should be of steel and cast steel respectively. Copper and bronze lose strength when subjected to the high temperature of superheated steam.

For equal engine power the cut-off for the high pressure cylinder should be somewhat increased; this usually can be done by adjusting the valve gear. It is recommended that for new construction the high pressure cylinder be made somewhat larger.

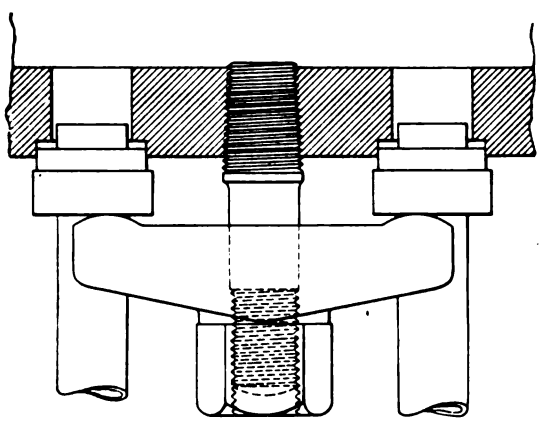


Fig. 4.—Superheater Pipe Joint

The Superheater Company reports over 2,000 ships which use their type of superheater. Among these there are vessels of the following nationalities: United States, Great Britain, France, Japan, Italy, Norway, Portugal and Holland. The horsepower of the various ships ranges from 400 to 20,000.

COMPARATIVE TEST DATA

As a specific case tests are here quoted, which were made on two tow boats belonging to the Lehigh Valley Railroad Company. Both were of the same type and nearly the same size and power. Each had triple expansion engines without steam jackets. Each had a single Scotch boiler having four furnaces using anthracite coal.

These tests show a clear gain of 17 percent in one case and of 15 percent in the other computed in pounds of coal, not allowing for variation in heating power of the fuel; were an allowance for the heating power to be made the former figure would be considerably greater. For both boats a larger power was developed with superheated steam; for tow boats a larger power may be as valuable as the saving in fuel, but for steamers in general such a statement cannot be made.

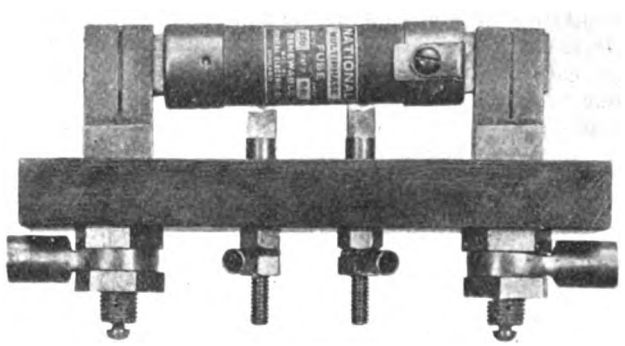
The Superheater Company presents evidence that certain steamers in regular service use from 1.2 to 1.4 pounds of coal per indicated horsepower per hour for all purposes. It may be possible in a later article to present and analyze reports from the use of superheated steam on such ships.

COMPARATIVE PERFORMANCES, SATURATED AND SUPERHEATED STEAM, OF LEHIGH VALLEY R. R. COMPANY'S TUGS IN TOWING SERVICE

	Lehigh		Perth Amboy	
	Sat.	Super.	Sat.	Super.
Duration of tests, hrs	46.92	85.5	47.58	54
Total tons of tow	3,451	5,149	3,322	3,502
Boiler pressure, pounds	173	173	186	187.5
Vacuum, inches	23.5	23.4	24.3	24.8
R. P. M	87.7	92.3	93	94.8
I. H. P	633	803	775	887
Temperature at throttle, F	376	575	382	590
Temperature feed water, F	233	230	222	224
B. T. U. per pound of coal	12,758	11,166	12,483	12,423
Coal per sq. ft. grate per hour, pounds	16.15	16.85	18.6	18.1
Coal per I. H. P. hour, pounds	2.29	1.90	2.61	2.22
Fuel economy	....	17%	....	15%
Displacement, tons	446	446	452	452

Renewable Fuses for Multiphase Motors

WHEN it was found that the relay system in connection with the control apparatus of multiphase motors could not be designed to prevent these motors from running single phase, the Federal Electric Company, of Chicago, developed a low voltage auxiliary coil as a part of their renewable cartridge fuses, which accomplishes the desired result. The new device, known as the "National" multiphase renewable fuse, serves two purposes: as a fuse it is so constructed that it withstands the high starting current of motors and also protects the running load within the limits prescribed by the Underwriters' Laboratories, Inc. It is of the powder packed type and has a metallic indicator which shows in plain view upon the outside of the fuse the rated amperage of the element with which the fuse is loaded. As the fuse is made for operation on a multiphase circuit, it acts as a circuit breaker; that is, when one fuse blows, the auxiliary coil in the fuse makes one of the elements in another fuse blow, thereby breaking the circuit entirely and eliminating the possibility of the motor running single phase. This action really has the effect of a time limit fuse. Only one element can be placed in the renewable fuse, so there is no danger of interruption of motor service or the necessity of rewinding motors which might be caused by overloading the fuses if two or more elements or a single element of too great capacity were placed in the fuse case.



Multiphase Time Limit Renewable Cartridge, Showing Back Connected

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Internal Combustion Engines Applied to Propulsion*

Comparative Earning Capacities of Motorships and Oil Burning Steamers — Machinery Equipment of Motorship William Penn

By John F. Metten and J. C. Shaw

AS with the steam engine, there is a limit in size of cylinder for a Diesel engine, and it would appear that a 31½-inch diameter is nearing this limit, due principally to liner thickness required. Considerations of convenience for handling the parts on board ship are also involved. It would seem that the next logical step with the four cycle engine for increasing the power to more than 500 indicated horsepower per cylinder is to resort to the double acting piston. From the standpoint of elimination of heat troubles, the condition is believed to be more favorable for the double acting four cycle engine than for the single acting two cycle engine, as the maximum temperature at the first part of the power strokes is alternately distributed to the two ends instead of continually to one end of the cylinder as with the two cycle.

Electrically Driven Auxiliaries

The adaptability of the motorship in having its auxiliaries electrically driven and the advantages resulting from the same were at the beginning recognized by Burmeister & Wain and incorporated in their first vessel. As the internal combustion engine by nature requires an external source of power for starting and maneuvering, the same power can be effectively used for other purposes as for driving pumps in engine room and deck machinery. The saving in fuel thus made, being about one-tenth that of a steam vessel when in port it should be observed, is due primarily to the efficiency of the Diesel engine driving generators and not so much to the electrical transmission as some have been led to assume.

In the earlier installations two large auxiliary engines were used, each driving a generator and compressor in tandem, the latter being uncoupled when in port. This was soon replaced by three, and now, as in some of the larger vessels, by four, small sets having generators only. The compressors on the main engines at the same time were changed from single high stage compressors, taking their air from the maneuvering air system to independent three stage compressors. For the two low pressure air compressors, one of which was always operated at sea, was substituted one motor driven compressor for maneuvering purposes only. This latter arrangement is better in that the high and low pressure air systems are not interdependent and the auxiliary power plant is more flexible. From an operating standpoint it is also better, as, by having more than two sets and being small in size, they can be overhauled in turn at sea, relieving the work of the engineers' personnel in port, whose time should then be given to more important port duties.

There has been much discussion as to whether the two or four cycle engine is better. Judged in the light of the number of motorships in successful operation, at present the four cycle has the decided advantage.

Two vs. Four Cycle Engines

The special claims made for the two cycle engine is that more power can be obtained per cubic space of cylinder, from having double the power strokes of a four cycle, and hence less weight and space occupied; also that the two cycle, having no exhaust valves to cause trouble, can burn the lower grade oils of high sulphur content.

The four cycle advocates dispute these claims by saying that the two cycle engine cannot run with as high mean pressures in the cylinders as the four cycle, if internal heat troubles are to be avoided, and that the combustion is not apt to be as complete as in the four cycle. They also point out the lower mechanical efficiency, resulting from negative work required for scavenging, and hence higher fuel consumption. With the rings passing across the open ports wearing conditions are not so good as with the unbroken liner surface of the four cycle, and the cylinder lubricating oil consumption is much higher than the four cycle due principally to the oil being scraped into these ports and blown out through the exhaust. It is also stated that with the long pistons required, scoring is apt to result from misalinement caused from wear at crossheads and guides. The two cycle originally dominated the field of the light high speed submarine engine, but after some ten years have been spent in its development it has been superseded in this field to a great extent by the four cycle. This would not have been possible if there is any inherent advantage in the two cycle as to weight for a given output. Moreover, in the long trade routes, which is the merchant motorship's chosen field, it must be obvious that the conceded superior economy of the four cycle will give an advantage in deadweight cargo capacity more than sufficient to offset the advantage in weight of machinery claimed, but not yet proved, by the two cycle advocates.

Some makers, who originally built four cycle engines and changed to two cycle, have in recent years changed back to four cycle, and others, who have always built the four cycle, are known to be experimenting with the two cycle. All experienced builders are fairly well agreed, however, that the Diesel engine works best at low speeds due to the nature of the injection and burning of the oil, and that the large cylinder engines better burn the lower grade oils. Oil of higher sulphur content, though, as commonly used under boilers, is not to be recommended, as the sulphuric acid formed in the burning not only affects adversely the exhaust valves of the four cycle engine but attacks impartially the exhaust pipes and other parts of either the four or two cycle.

Solid Fuel Injection

Some makers have advocated the solid injection or injection of the fuel by pressure alone, with which Vickers has been most successful. The chief difficulties encountered with such a system are in getting good combustion at all running speeds and loads and the elimination of the shock in the cylinder, which is apt to occur with the sudden rise in pressure when fuel is injected. The advantage claimed is that compressor troubles are entirely eliminated with a correspondingly higher mechanical efficiency obtained than with air injection. The fuel consumption, often erratic, however, under the most favorable conditions, is no better than the air injection full Diesel. It is also questioned if an oil pressure from 2,500 to 4,000 pounds per square inch is more to be preferred than an air compressor and its corresponding air system having a pressure of 850 to 900 pounds.

The Diesel electric drive has been suggested by some, using direct current supplied by several high speed engine sets working in series. The sponsors of this system apparently have either taken their cue from the turbine electric drive or are more familiar with the electric end than the shortcomings

*From a paper read before the Society of Naval Architects and Marine Engineers, New York, May 26.

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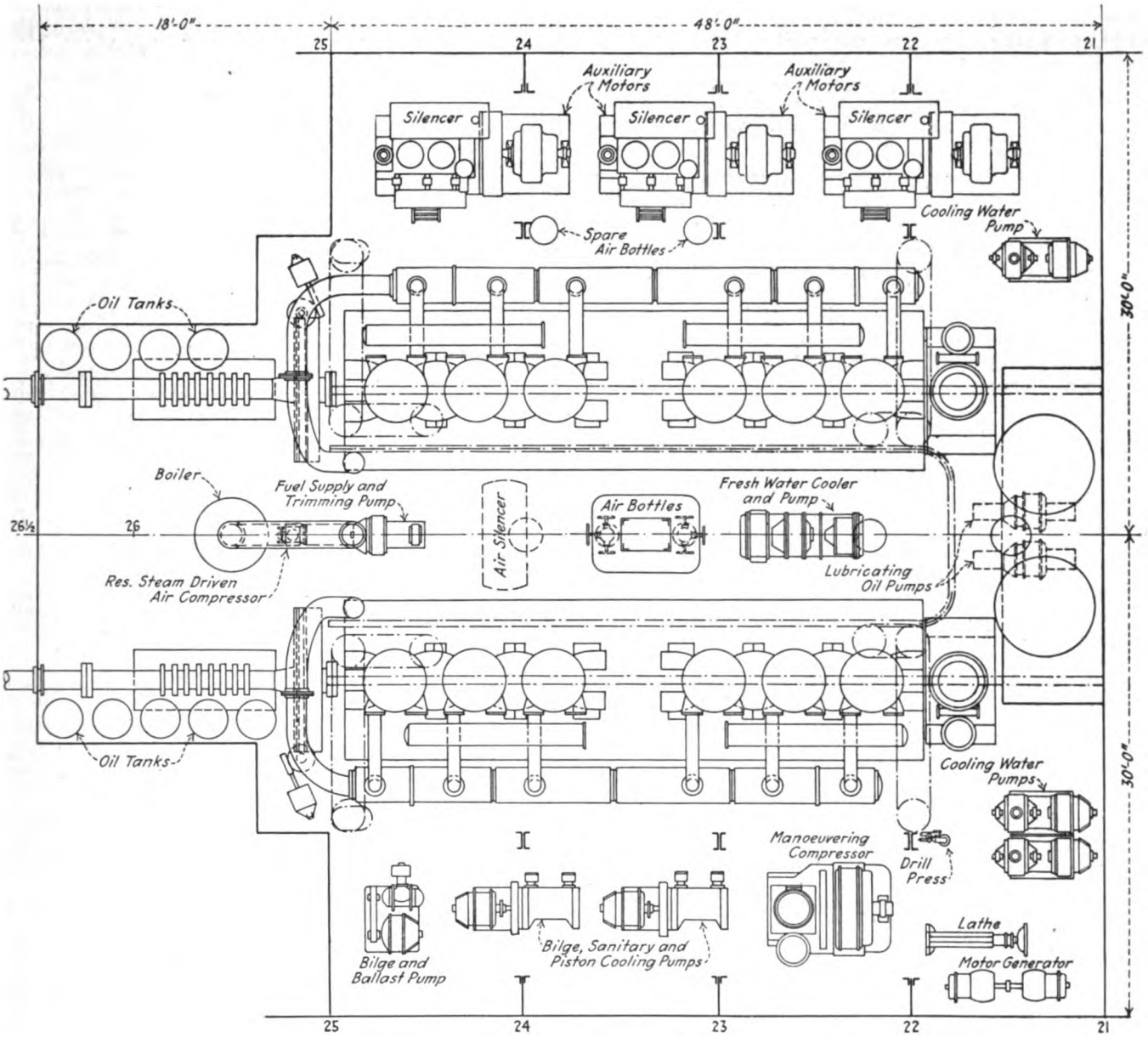

Arrangement of Machinery, Motorship William Penn

of the high speed Diesel engines. To reduce the weight of the engines and space occupied sufficiently to compensate for the additional electrical equipment involved, the engines must necessarily be high speed and of the trunk piston type. The engines would correspond in design to that halfway between land and submarine practice.

DISADVANTAGES OF DIESEL ELECTRIC DRIVE

The disadvantages of such a system compared with the direct drive are as follows:

1. Loss in reliability in the prime movers.
2. More major overhauls, as lifting of cylinder covers and drawing of pistons, due to poorer combustion and passage of lubricating oil from crank case.
3. About 30 percent more fuel per knot, 15 percent chargeable to higher fuel consumption of engines and at least 15 percent electrical losses with the small size generators used.
4. Lighter grade and more expensive fuel oil required.
5. Much higher lubricating oil consumption associated with high speed and trunk pistons.
6. Possible vibration troubles associated with high revolutions.
7. Necessity for using objectionably large motors of the commutator type for transmissions of power from engines to propellers.
8. Greater complication of controls and more expert knowledge required of the engineer personnel.
9. Tendency to overwork the personnel with the frequent overhauls required with high speed engines when operated continuously at full power.
10. Danger of short circuits.
11. Short life of high speed engines compared with slow speed engines.
12. Higher first cost and maintenance charges.

With the higher consumption of fuel and lubricating oil per indicated horsepower combined with the electrical losses involved and the better quality of fuel oil required, the total expenditure for these items will be about 50 percent more than with the direct drive system.

The Diesel electrical system has been specially recommended for converting existing steamers. It is believed by the authors that this can be far better accomplished by using a long stroke engine turning at the low revolutions required. Work has been done along these lines by Doxford and Cammell-Laird, using the doubled opposed piston, and also Burmeister & Wain have developed a line of long stroke engines, with a stroke bore ratio of two to one, specially adapted to single screw vessels. These latter engines are to be recommended for new vessels, as well, of 5,000 tons deadweight and less, on account of less engineroom personnel required, important in small vessels, and the dispensing with one shaft alley, which is also important in this size ship.

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For new motorship construction, over 5,000 tons deadweight, two screws are to be recommended. In smaller vessels there is little difference in propulsive efficiency between single and twin screws. For larger ships, however, the efficiency is more favorable with the two shaft arrangement due to well known conditions affecting propeller performance, including the better immersion of the two smaller propellers under all conditions of draft. In the larger vessels, also, the saving in space by having only one shaft alley is not so important, and the length of engineroom will be less with the higher speed standard stroke engines.

A comparison will be given showing the estimated increased earning capacity of a motorship over a corresponding oil burning steamer as can be anticipated in actual service. The size of vessel chosen has the same general dimensions as the motorship *Afrika*, owned by the East Asiatic Company, and which is similar to the *William Penn* and the two motorships building for the United American Lines.

Comparative Earning Capacities of Motorship and Oil Burning Steamer

The steamer is single crew with double reduction gearing and compound turbines and Scotch boilers. The revolutions for the vessel are taken as seventy, which is conservative practice, to favor propulsive efficiency which for convenience here is assumed the same as the twin screw vessel.

The ships are of the awning deck type having a nominal deadweight carrying capacity of 13,000 tons when loaded to 31 feet 5 inches draft. They are 445 feet between perpendiculars, 60 feet beam and 42 feet molded depth, with a block coefficient of 0.782. The shaft horsepower of the turbines is taken as 3,500 which is equivalent to the 4,500 indicated horsepower of the Diesel engines. The cost of the vessels to build, based on probable cost of labor and material in the immediate future, is assumed $150 per ton for the steamer and $165 for the motorship. The $200,000 additional cost of machinery for the motorship, including deck machinery, is considered fair where the Diesel work is well standardized.

The fuel oil consumption at sea for the steamer with 16 degrees Baumé oil is taken as 0.95 pound per shaft horsepower, all purposes, which should be realized in service with properly designed turbines and double reduction gears and coordination of auxiliaries. For the motorship, with oil of 22 degrees Baumé, the consumption is taken as 0.31 pound per indicated horsepower all purposes, which is usual with motorships belonging to the East Asiatic Company. The cost of oil in American port, per recent quotations, is $2 for fuel oil for steamer and $2.30 for Diesel oil of gravity indicated. It is necessary for the steamer to take on additional oil in a foreign port which is assumed double that in an American port.

The route chosen is from San Francisco to the Far East and return, calling, for example, at Yokohama, Hong Kong, Manila and Honolulu, with a total distance of 15,500 knots. The number of days at sea and in port is taken from percentages for similar vessels operating over similar routes, and the number of days in port include that for loading and unloading, repairs and docking, holidays, etc.

The cost of personnel is based on the scale of wages in effect the first part of this year with sustenance at $1.25 per man. This is estimated with 27 for the deck officers and crew for either vessel, and for the engine room 19 and 14 men respectively for the steamer and motorship.

The freight rate for bulk cargo is estimated as $27 per 100 cubic feet and for deadweight cargo as $13.50 per ton, which is fairly well in accordance with present rates.

The itemized figures are as follows:

	Steamer	Motorship
Displacement, tons	18,690	18,730
Gross tonnage, tons	9,059	9,050
Actual mean sea speed, knots	11.5	11.5
Revolutions per minute	70	115
Indicated horsepower	.....	4,500
Shaft horsepower	3,500	.....
Total weight of machinery (tons), including pipes, ventilators, ladders, floor plates, spares, tools, outfit, propellers, shafting, etc	690	911
Water in system, tons	115	14
Weight of deck machinery, tons	140	155
Weight of hull fittings, equipment, etc., tons	4,575	4,600
Light displacement, tons	5,520	5,680
Capacity, deadweight, tons	13,170	13,050
Capacity (bales), cubic feet	590,000	620,000
Oil bunker capacity, tons (double bottoms)	1,320	1,350
Oil bunker capacity, tons (tank between tunnels)	.....	120
Oil bunker capacity, tons (settling tanks)	80	20
Total oil bunker capacity, tons	1,400	1,490
Oil consumption per shaft horsepower, main engines, all purposes, pounds	0.95	.....
Oil consumption per indicated horsepower, main engines, all purposes, pounds	.....	0.31
Oil consumption per day at sea, tons	35.65	14.95
Oil consumption per day in port, tons	5.5	.7
Number of days at sea, per annum	220	220
Number of days in port, per annum	145	145
15,500-Knot Voyage		
Days at sea	55.5	55.5
Days in port	36.5	36.5
Total oil consumption at sea, tons	1,980	830
Total oil consumption in port, tons	200	26
Reserve oil bunker (for about six days), tons	220	90
Total oil carried, outbound, tons	1,400	946
Total oil burned on trip out, tons	1,090	428
Total oil necessary, homebound, tons	1,310	518
Oil to be purchased abroad, tons	1,000	0
Weight of crew and stores, tons	50	50
Fresh water on board at start of each leg, tons	300	75
Total weight of vessel, including fuel, water, etc., outbound, tons	7,270	6,751
Total weight of vessel, including fuel, water, etc., homebound, tons	7,180	6,323
Cargo capacity, outbound, tons	11,420	11,979
Cargo capacity, homeward, tons	11,510	12,407
Cargo capacity, average (two ways), tons	11,465	12,193
Cost of Operation Per Voyage		
Insurance (4 percent; depreciation 5 percent), 92 days	$44,200	$48,800
Brokerage, at 8|15 per ton cargo capacity	3,440	3,660
Overhead and general expenses at $20 per gross ton, per annum	45,600	45,600
Fuel oil	45,900	15,260
Water, at $1 per ton	600	150
Deck officers, crew, stewards	12,200	12,200
Engineer personnel	9,300	7,600
General stores, deck, engineers and stewards	5,000	5,000
Totals	$166,240	$138,270
Loading and discharging of deadweight tons at $1 per ton and 75 percent of cargo capacity	$17,200	$18,280
Total cost for deadweight cargo (per voyage)	$183,440	$156,550
Loading and discharging of bulk cargo at $2 per 100 cubic feet at 75 percent capacity	17,700	18,600
Total operating cost for bulk cargo (per voyage)	$183,940	$156,870
Comparison of Earnings with Deadweight Cargo Carried		
Tons per voyage outbound at 75 percent capacity	8,500	8,980
Tons per voyage homeward at 75 percent capacity	8,640	9,300
Rate per ton	$13.50	$13.50
Gross revenue per voyage at 75 percent capacity	$232,500	$246,780
Cost of operation per voyage	$183,440	$156,550
Net revenue per voyage	$49,060	$90,230
Net revenue per annum	$195,600	$358,900
Percent earned on investment	10	16.65
Comparison of Earnings With Bulk Cargo		
Cubic feet of cargo carried out and return at 75 percent capacity	885,000	930,000
Rate per 100 cubic feet	$27	$27
Gross revenue for bulk cargo	$239,000	$251,100
Cost of operation per voyage	$183,940	$156,870
Net revenue per voyage	$55,060	$94,230
Net revenue per annum	$218,500	$374,000
Percent earned on investment	11.2	17.4

From the foregoing it will be seen, for the particular conditions chosen, that the motorship has an increased earning capacity over the steam vessel of 66 percent on deadweight and 55 percent when bulk cargo is carried. In addition to the bulk cargo, there can be carried on the outbound trip 544 tons of oil, which, at $13.50 per ton, will increase the amount earned on investment from 17.4 percent to 18.73 percent or 67 percent better than the steamer.

The above figures can be used as a basis for working out a comparison for any route which will vary directly with length of voyage and the size of the vessels employed.

The Motorship William Penn

A brief description of the motorship *William Penn* will be given, as it was the first large vessel of this kind owned by

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the United States Shipping Board. The performance of this vessel in service will be of particular interest, as it is to be operated over the same route and by the same operating company as the electrically driven ship *Eclipse*, recently put into service.

The hull, having been originally intended for a 3,000 shaft horsepower single screw turbine installation, is not exactly suitable to the Diesel engine installation of 4,500 indicated horsepower, or 3,500 shaft horsepower. For best efficiency, due to its high block coefficient, the vessel should not be driven over 10½ to 11 knots in service. The screws have accordingly been designed for lower turns than that for which the engines were intended, so that the designed mean indicated pressure, upon which the efficiency of engines somewhat depends, will be maintained.

The *William Penn* has a length between perpendiculars of 439 feet 6 inches, a beam of 60 feet, a depth molded to shelter deck of 36 feet 8 inches, and a draft of 28 feet 4¾ inches, corresponding to 12,375 tons deadweight. The length of engine room space was maintained the same as for the steam driven sister ships. A built-up column was added to tie the middle of the engine room double bottom to the shelter and bridge decks, to prevent possible synchronous vibrations being set up between the main engines and the hull's structure.

The main engines are, as previously stated, six cylinders, each of a bore and stroke of 740 millimeters and 1,150 millimeters, respectively. Along the port side are arranged the three auxiliary engines each driving 65 kilowatt generators, and along the starboard side the maneuvering compressor and bilge and ballast pumps. The lubricating and salt water cooling pumps are placed near the forward bulkhead and the fuel oil pump and reserve air compressor aft, between the main engines. In this vessel a fresh water closed cooling system, with cooler and fresh water pump, has been added for the cooling of the cylinders and covers. This is a precaution against mud being deposited in the spaces, which is liable to occur with deep draft vessels when navigating shallow waters and rivers. The salt cooling water is maintained for the main compressors and piston cooling, which is also used for cooling the fresh water.

Germany to Build High Powered Diesels

By Our Special London Correspondent

The prolonged coal strike in England has afforded a remarkable advertisement for the motorship and it is a fact of more than ordinary significance that while there are now millions of tons of steamships laid up, there do not appear to be any large motor vessels idle at the present time. Attention is now being concentrated on the construction of high powered engines and it will probably surprise most shipowners and shipbuilders to learn that Germany is making a determined attempt to lead the way in this sphere.

THE Hamburg South America Line is having built a large motorship in which a couple of 3,000 brake horsepower Sulzer Diesel engines will be installed. These engines are under construction at Sulzer's German works at Ludwigshaven and are the biggest of the type yet built for marine purposes. They are six cylinder engines with a diameter of 680 millimeters and a stroke of 1,100 millimeters developing their full power at 100 revolutions per minute. From the purely technical point of view, these engines are noteworthy in that they inaugurate a novel system of scavenging which Sulzers have now decided to employ in all their large sets.

Turbo Scavenging Pumps for Diesel Engines

In the Sulzer engine the principle of scavenging is to have two series of scavenging ports at the lower end of the cylinder, the bottom one being opened and closed by the passage of the piston in the course of its stroke, while the supply of scavenging air entering through the upper ports is controlled by semi-rotary valves operated from a horizontal spindle in the scavenging trunk. Sulzers have retained this general design but instead of supplying the scavenging air from a vertical pump driven directly off the engine, two electrically driven turbo scavenging pumps are installed in the engine room, one of which will supply sufficient scavenging air for both the propelling engines, the other remaining as a stand-by. In this way it is possible to obtain an extra 6 or 7 percent power on the shaft as this is the amount normally absorbed by the scavenging pump. Moreover it is claimed that no larger electric generating sets are required in the engine room since in any case with electrically driven winches it is necessary to install an electric generating plant of sufficient power to operate them when in port. When at sea this same power can be used to drive the scavenging pumps and no additional plant is necessary.

Taking a ship equipped with two 2,000 brake horsepower Diesel engines, and provided with electrical auxiliaries, the auxiliary generating plant might comprise two 400 horsepower sets. The scavenging pumps needed would be two of about 250 brake horsepower, one being sufficient for supplying scavenging air to both engines. When in port, one generating set would be sufficient to operate all the winches, while at sea one set would also carry out the whole of the work required including driving the scavenging pump and all the minor electrical auxiliaries.

A Geared Diesel Engined Liner

Among other high powered motorships that will shortly be built are two equipped with 6,000 horsepower machinery for the Hamburg America Line, now approaching completion at Hamburg. These are remarkable as forming the first examples on a large scale of the application of geared Diesel drive. In these vessels the twin screw engines, each of 3,000 horsepower, run at 390 revolutions per minute and drive the propellers at about one quarter of this speed through the intermediary of ordinary mechanical gears. The engines are two of the numerous sets which were actually built during the war for installation in submarine cruisers and have ten cylinders of 550 millimeters bore and stroke. They are four cycle M. A. N. machines and are similar to the submarine engines used in the German Navy during the war except that the number of cylinders has been increased from six to ten.

5,000 Horsepower Camellaird Fullagar Engine

In view of the attention now being paid to the Camellaird Fullagar engine it will interest engineers, shipowners and

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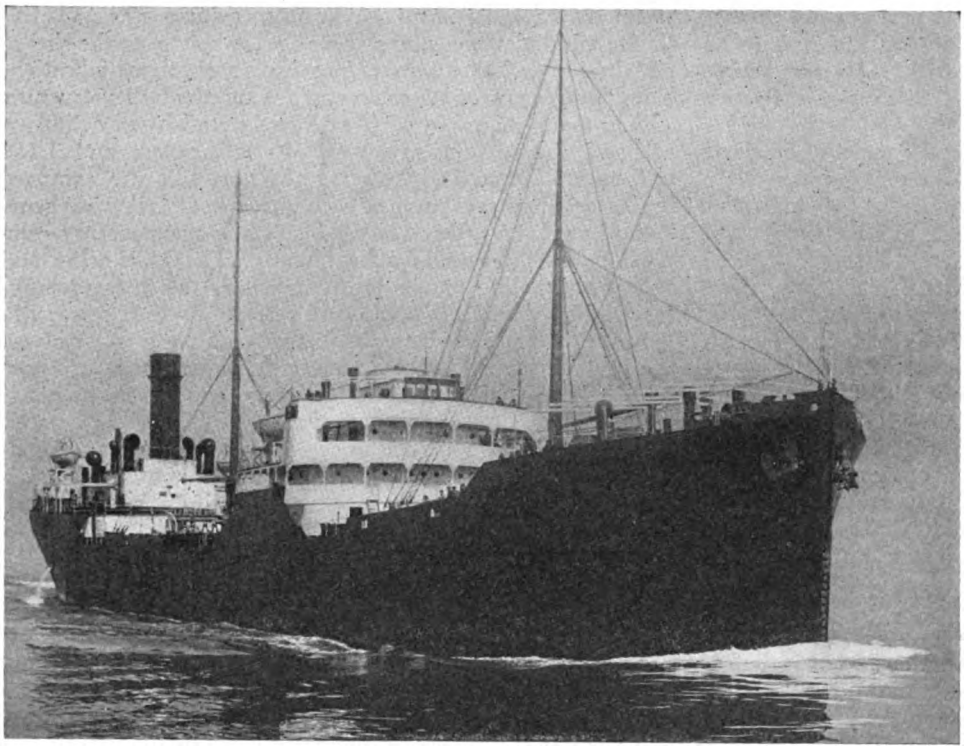

Fig. 1.—The 10,000-Ton Motor Tanker Seminole Built and Engined by Vickers for the Anglo-American Oil Company

shipbuilders in the United States to know that the largest individual marine engine now being built is one of this design under construction at Cammell Laird's own works at Birkenhead. It is to develop 5,000 brake horsepower in six cylinders running at 95 revolutions per minute, the cylinders being only 26½ inches in diameter with a stroke of 42 inches.

Cammell Laird's has just completed a twin screw set of two 1,000 brake horsepower engines, the largest of this type yet built. The illustration shows these on the test bed on the occasion of their official trial run. They develop their normal power of 1,000 horsepower at 115 revolutions per minute and have four cylinders 18½ inches diameter and 50 inches combined stroke. The principle of operation of the Camellaird Fullagar type is now so well known that it need not be explained but the most interesting fact in connection with the trials of the engine is that they achieve what is apparently a record fuel consumption for ordinary Diesel engines as this works out at 0.39 pound per brake horsepower hour. Remembering that it includes the fuel required for operating the scavenging pump, the three stage air compressor, the circulating water and lubricating oil pump, it will be agreed that the result is noteworthy, exceeding in economy as it does the most efficient four stroke design which has as yet been worked out.

RESULTS WITH THE STILL ENGINE

The first official test results of the Still combined steam and oil engine are now available and although they are better than anything that has yet been recorded, there is still some doubt whether the complication of adding a steam boiler with the necessary pumps to the Diesel engine, not to speak of the steam valves on the working cylinder, is warranted by the economy compared with the ordinary Diesel motor. The lowest figure recorded on the trials at full load of a single cylinder engine developing about 350 brake horsepower was 0.375 pound per brake horsepower hour. This included all the auxiliaries, as well as a separately driven scavenging pump which incidentally absorbs only four percent of the total power. This engine has been built at Scott's Shipbuilding and Engineering Works on the Clyde and details of it were recently published.

It is hoped by the manufacturers that still better results will be achieved and in any case it is of course not possible to obtain the maximum efficiency on a single cylinder unit. The engine will be built as a six cylinder machine developing 2,000 brake horsepower and it is hoped that on this engine consumption, overall, of less than 0.36 pound will ultimately be achieved.

A number of interesting motorships have been launched

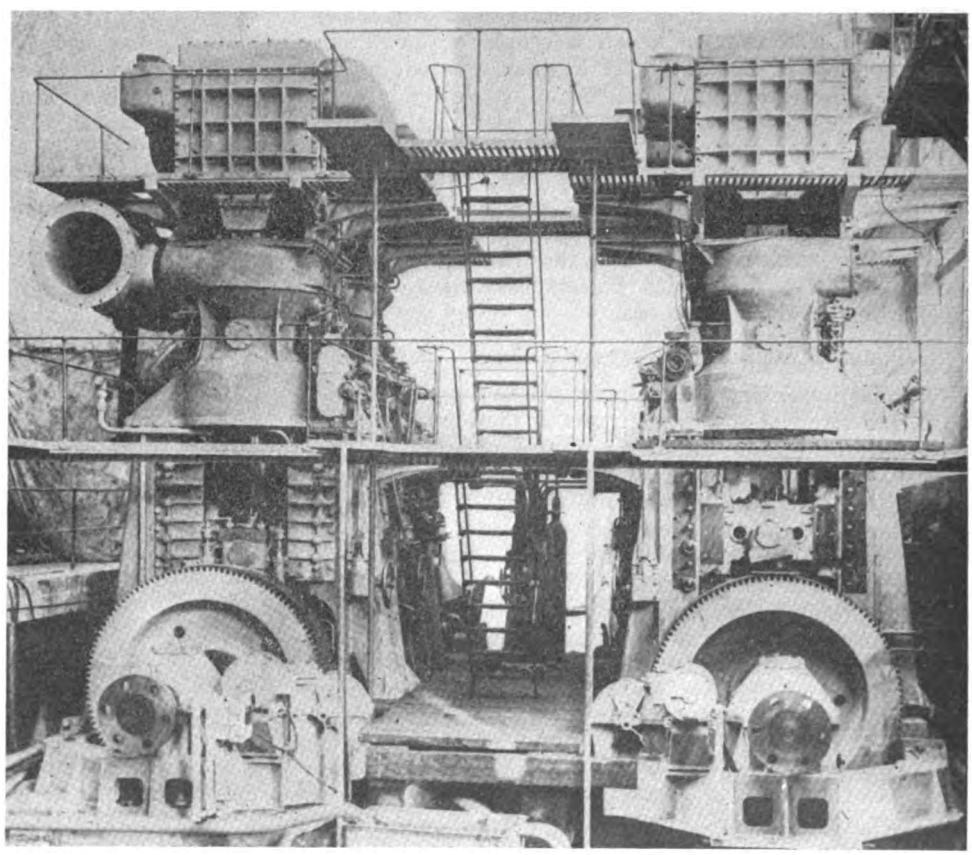

Fig. 2.—Two 1,000-Brake Horsepower Cammellaird-Fullagar Diesel Engines—the Largest of the Type Yet Built

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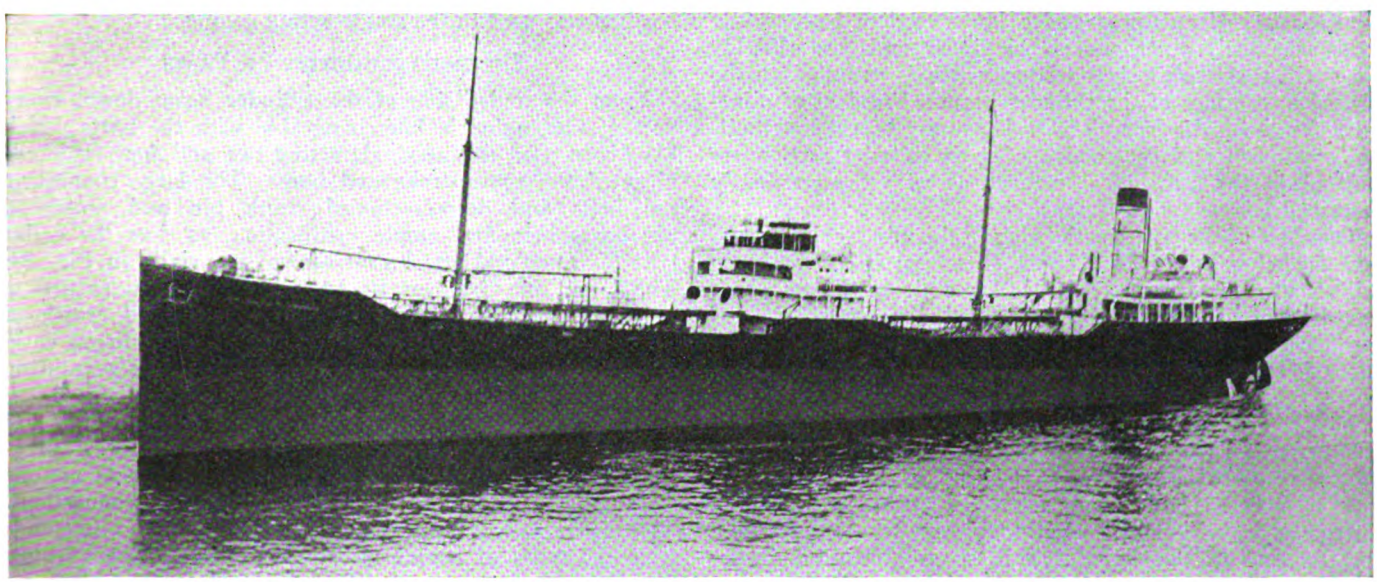
or completed during the past few weeks including the *Seminole,* now trading between England and New York, and an oil tanker built by Vickers for the Anglo American Oil Company. This is a second ship to have the standard Vickers solid injection Diesel engine, which is proving much more successful than the opponents of the solid injection system anticipated would be the case. This 10,000-ton ship with a speed of 11 knots has a fuel consumption of only about 10 tons daily.

Another new ship is the ore carrying vessel *Strasse* for the Grangesberg Oxelsund Company built by Götaverken and designed to carry about 8,000 tons, while a third is the Tosi engined *Primula,* one of the first ships in which machinery of this type has been installed. The motorship *Sardinia,* a single screw vessel with a 2,100 horsepower Werkspoor engine, has recently been completed and two or three others will shortly be finished.

Progress in motorship building is proceeding along steady lines in spite of the desperate shipbuilding slump which in fact will probably prove a blessing in disguise for the motorship builders.



S. S. Henry Deutsch De La Meurthe: Deadweight Tonnage, 8,350; Indicated Horsepower, 2,833; Speed, 12.90 Knots

Tankers Delivered to Lux Navigation Company

FOLLOWING a very successful deep sea trial run on May 20, the second of two steel tankers built at the Sparrow's Point Plant (Baltimore, Md.) of the Bethlehem Shipbuilding Corporation, Ltd., for the Lux Navigation Company, London, Eng., has been delivered to her owners. The first one of these tankers was delivered on May 10.

The *Henry Deutsch De La Meurthe* and the *Emily Deutsch De La Meurthe,* as the vessels are named, are similar in design to the well-known "Shell" tankers, and are built on the longitudinal system of framing. They are classed at Lloyd's highest rating. The total carrying capacity of each of these tankers is 8,350 tons deadweight on a mean draft of 24 feet 9 inches, with an oil cargo capacity of about 7,600 tons. The principal particulars are as follows:

Length overall, 427 feet.
Length between perpendiculars, 412 feet.
Extreme breadth, 53 feet 3½ inches.
Molded breadth, 53 feet 1 inch.
Molded depth to upper deck, 31 feet.
Molded depth to main deck, 24 feet.
Speed, 11 knots.
Type of engine, reciprocating.
Size of engine, 27 inches by 45 inches by 75 inches by 48 inch stroke.
Boilers, Scotch.
Number of boilers, 3.
Steam pressure, 180 pounds per square inch.
Kind of fuel, oil and coal.

The Bethlehem (Dahl) mechanical oil burning system is installed on each vessel, and the boilers are fitted with Howden's forced draft furnace fronts suitable for conversion to coal burning if desired. The engines and boilers are placed aft with the fuel oil tanks forward of the boilers. Bethlehem-Weir horizontal fuel oil pressure pumps, 6 inches by 4 inches by 8 inches, are installed in duplicate for supplying oil to the burners. The pump room is located near amidships, and is approximately 8 feet long and of the same width as the vessel.

Two Bethlehem-Weir vertical simplex cargo pumps, 18 inches by 16 inches by 24 inches stroke, are utilized for handling the oil cargo on each ship. Feed, drain, fuel oil transfer, ballast and deck, and donkey and fire pumps are of the same type. The main circulating pump is a 14 inch double suction centrifugal type, direct connected to an 8 inch by 8 inch vertical single steam engine. The deck machinery for each vessel consists of two 8¼ by 8 inch gypsies located on the upper deck, a hand operated capstan on the forecastle deck, two 8¼ inch by 10 inch compound geared winches on the upper deck, a 10 inch by 10 inch triple spur geared windlass, and a 9 inch by 9 inch horizontal spring-quadrant steering gear controlled by hydraulic telemotor. The auxiliary machinery was built at the Moore Plant of the Bethlehem Shipbuilding Corporation, Ltd.

On the trial of the *Henry Deutsch De La Meurthe,* which was run on April 21, an average speed of 12.90 knots was maintained at a mean draft of 24 feet 9 inches. An average of 2,833 indicated horsepower was developed at an average engine speed of 79.34 revolutions per minute. On the trial of the *Emily Deutsch De La Meurthe,* which was run on May 20, the average speed maintained was 12.36 knots at a mean draft of 24 feet 10 inches. An average indicated horsepower of 2,985 was developed at an average engine speed of 79.25 revolutions per minute. During the trials of both vessels the fuel burned was oil with a gravity of 28 degrees Baumé.

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Standardized Diesel Engines—V*

Discussion of the Double Acting Two Cycle Engine and Its Possibilities

By H. R. Setz

THE climax of the general engine structure with automatic plate valve port scavenging control, described in the previous issue, is reached in the double acting two cycle engine. An examination of Figs. 23 and 24 shows such a design based on the same bore and stroke dimensions as in the single acting four cycle and two cycle engines shown respectively in Figs. 2, 3, 16 and 17. The cylinder proper here consists of an upper and a lower section, both rigidly held near their outer ends; their inner ends are slidably centered in a separate belt section which is mounted on the planed upper face of the cylinder beam. Freedom of alinement for each cylinder unit as well as unrestricted longitudinal expansion and contraction of each cylinder section are insured in the same ideal manner as with the previously described engine types.

One-half of the port length being in the upper cylinder end and the other half in the lower, these can be conveniently milled out of the solid cylinder wall to a nicety of form which greatly contributes to a clearly defined direction of flow of the scavenging air when entering the cylinder. To facilitate ease of travel of the piston rings over the gaps necessary between the cylinder ends to allow for expansion, these are made staggered relatively to each other between consecutive ports. An axial contact surface between the cylinder ends, located between the scavenging and exhaust ports, checks the flow of exhaust gases through the expansion gap without restricting movement of the cylinder ends. Indirect cooling for the ends of the cylinder wall around the ports is obtained by direct contact over their entire outer surface with thoroughly water cooled walls of corresponding contour in the surrounding belt section.

Transmission of Longitudinal Working Loads

A feature worthy of special notice is the transmission of the longitudinal working loads through the outer cylinder wall directly to the cylinder bolts without causing the belt section containing the ports to participate in any load transmission. The latter is at all times under compression, a feature especially pronounced on the exhaust port side; the advantages of this will be appreciated, if it is remembered that cylinder trouble on many early two cycle engines could be directly traced to the absence of such provisions. Surrounding this belt section with the ports we have again the scavenging air receiver, here built up of easily removable steel plates and running the entire length over the top of the cylinder beam.

Owing to the use of the port scavenging control already described and illustrated in Fig. 19, the high pressure ends of the cylinder castings have been stripped of the multitude of valve pockets and irregular passages which have so enormously complicated double acting engines, both two cycle and four cycle, as heretofore built. The elimination of valve operating gear with the inevitable cumbersome linkage and mechanism indispensable for actuating valves in different planes and different centerlines simplifies the construction so much that the double acting feature is at first hardly recognized.

An examination of the sectional view (Fig. 23) shows that these results have been accomplished without introducing a single element which has not been tried and proven by well matured experiences gained from double acting gas and Diesel engines of large capacity. Such features are the joint between the two cylinder sections in a plane through the ports, the water cooled metallic stuffing box and the lower cylinder head with integral water jacket which is assured of the desired flexibility because of the large difference in diameter between the inner and outer walls. The upper end of the cylinder is closed off by the same cylinder head as was used in the single acting engine.

Interchangeability of Parts

From the under side of the cylinder beam down, every part of the engine is interchangeable with the parts which have been used on the single acting two and four cycle engines of the same stroke and bore. The large connecting rod bolts and deep sectioned crank pin and crosshead pin boxes here find ample justification, as does the collar type of piston rod attachment shown sectionally in Fig. 24. The latter, by virtue of its heavy backing nut, ensures a positively secured joint between piston rod and crosshead while the engine is in operation, at the same time greatly facilitating the loosening of this connection and permitting withdrawal of the piston rod through the stuffing box.

A valuable advantage of this arrangement, which has helped to make it popular in large modern engine practice, is the ease with which clearance adjustments can be made without affecting the piston cooling water connections. The piston cooling gear can be taken over just as it stands from the types of engine already described. The effective diameters of the piston cooling tubes had to be made large for considerations of staunchness rather than of water conveying capacity; even for the increased requirements of a double acting piston they are more than sufficient.

Operation of Fuel Valve

What mechanical valve gear remains is confined to the camshaft, push rods and levers required to operate the fuel valve. Referring to Fig. 23, it will be seen that only one fuel cam is required per cylinder, or no more than were needed for the single acting two cycle engine. Since the rollers for head end and crank end are spaced 180 degrees apart, the proper timing of injection for the head end and crank end working strokes is automatically spaced at the proper interval.

The operation of tappet rod A by means of sector lever F (Fig. 25) is chosen for the two reasons that it permits varying needle lifts during operation and makes roller clearances and adjustments immune against upward or downward cylinder expansion. The shaft which constitutes the fulcrum for lever F, and to which arm E is keyed, is centered at M. The only effect of moving the center H upward or downward is to cause a minute change R in the radial distance of the contact point between tappet rod A and lever F, and consequently a change of no measurable magnitude in the lifts of the needle N. If, however, it is desired to vary the lifts of the needles in order to meet operating conditions, a movement of shaft M and lever E varying the tappet rod position anywhere between A and A_1, accomplishes this result without at the same time disturbing the timing in any way. By swinging tappet rod A entirely clear of the working surface on lever F into position A_2, the fuel valve will be put out of operation. This corresponds to the "stop" position on the hand maneuvering gear of the engine.

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THE ULTIMATE TYPE OF RECIPROCATING ENGINE ATTAINED

With this two cylinder double acting construction we have arrived at the ultimate type of reciprocating engine; two power strokes from each cylinder per revolution and therefore the same degree of material utilization as is characteristic of the steam engine with the same fewness of parts. Like the latter, the favorite Diesel engine arrangement will be in the form of three cylinder units, for all except the largest sizes when four cylinders will be resorted to. Owing to the higher mean effective pressures obtained in the Diesel engine, its cylinders become smaller and the weight and space requirements less than those of a steam engine of the same number of cylinders, rotative speed and capacity. Over the latter the Diesel engine possesses the enormous advantage of having all its cylinders and the parts that go with same alike and interchangeable. The "individual job" feature so pronounced especially on marine

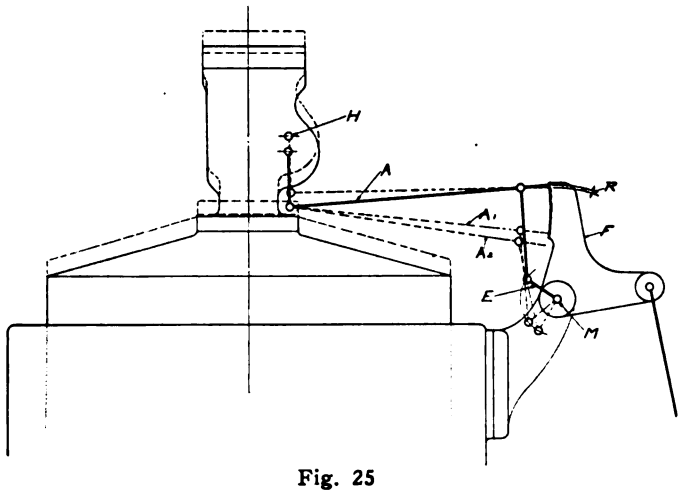

Fig. 25

steam engines is eliminated and in its place we have duplication of parts and quantity production.

As the foregoing exposition shows, this feature of duplication of parts inherent in all Diesel engines can, by consistent design, be expanded into a most pronounced duplication of use of the same parts on various types of engines. In this manner it becomes possible to distribute the appreciable first cost of one set of patterns, tools and fixtures over a line of units having a wide range of capacity and application, a manufacturing advantage of almost revolutionary significance.

Not the least economy and adaptability to meet a wide range of demands is furnished by the fact that in plants where the nature of service requires units of different capacities this can be met to a heretofore unknown extent with engines of the same bore and stroke of the double acting type for the larger units and single acting ones for those of smaller capacity; the latter can, by the use of identically the same framing and over 90 percent of the same moving parts, always be converted into units of greatly increased capacity at an almost nominal expense, a feature of importance alike for stationary and marine installations. The spare parts to be carried for either type of installation are virtually the same.

POSSIBILITIES OF THE DOUBLE ACTING TWO CYCLE ENGINE

The extraordinary possibilities of the double acting two cycle engine are strikingly brought out by means of the comparative figures of Tables I and II. The first of these shows capacities, weights and principal overall dimensions of a set of three four cylinder engines having the same bore and stroke, built on the same bedplate and having all parts below the under surfaces of the cylinder except the four cycle crank shaft alike and interchangeable.

The four cycle engine is credited with higher rotative and piston speeds and also is based upon a greater mean effective

TABLE I

	Four-Cycle, Single-Acting	Two-Cycle, Single-Acting	Two-Cycle, Double-Acting
Number of cylinders	4	4	4
Speed, revolutions per minute	140	125	115
Continuous load capacity, brake horsepower	520	825	1,500
Weight of engine complete, including piping and grating, tons	76	*85	*97
Weight per brake horsepower, pounds	327	230	147
Overall length	22' 0"	23' 6"	24' 6"
Maximum height centerline shaft to highest point on engine	14' 6"	14' 6"	16' 10"

TABLE II

	Four-Cycle, Single-Acting	Two-Cycle, Single-Acting	Two-Cycle, Double-Acting
Number of cylinders	6	4	3
Continuous load capacity, brake horsepower	1,500	1,500	1,500
Speed, revolutions per minute	120	115	110
Bore and stroke, inches	27 by 42	25½ by 40	23 by 36
Mechanical efficiency, percent	74	72	79
Mean effective pressure, pounds per square inch	93	88	80
Weight of engine complete, including piping and grating, tons	235	*160	*100
Cost of manufacture, including patterns	$145,000	*$105,000	*$65,000
Overall length	39' 6"	28' 10"	21' 6"
Maximum height centerline shaft to highest point on engine	18' 9"	16' 10"	18' 3"
Fuel consumption per 24 hours, tons	6½	7	7¼
Lubricating oil consumption per 24 hours, gallons	30	40	20

*Including centrifugal scavenging pump.

pressure because of the low material utilization characteristic of this engine. Owing to the greater frequency of load and heat applications, and because scavenging in the lower ends of the cylinders is somewhat interfered with by the presence of the piston rods, a speed of only 115 revolutions per minute is assumed for the double acting engine and a similarly conservative rating has been observed for the mean effective pressure.

Even with these reductions, the double acting engine excels by a wide margin. The differences in weight are brought about, aside from the necessity of a scavenging air pump in the case of the two cycle engines, by the different sizes of maneuvering compressors needed for each type of engine, according to its capacity, which also accounts for the slight variations in overall length.

Table II shows a set of engines compared on a basis of equal horsepower. Similar reservations in regard to speeds and mean effective pressures, giving due consideration to the size of cylinders, have been made here as in Table I. A particularly low mean effective pressure rating has been assumed for the double acting engine, not so much with the idea of accepting this as the normal working load, but rather to emphasize its advantages compared with the single acting units whose higher rating more nearly corresponds to best modern practice.

The drastic reduction in number of cylinders from the four cycle single acting engine up to the two cycle double acting machine is accompanied with an almost equally emphatic reduction in bores and strokes. The decrease in number of cylinders enormously shortens the bedplate and renders it less sensitive to deflections due to inaccuracies of foundations or to the deformations of a ship's hull at sea. Owing to the shorter stroke the bedplate also becomes narrower, a circumstance which, together with the small flywheel that can be used here, makes it possible to place a double acting two cycle engine further aft in a boat, thus shortening the line shafting and tunnels.

The fuel consumption of the four cycle engine is somewhat lower than that of the two cycle units but it is by far the most expensive to build; on the other hand, lower grades and therefore cheaper fuels can be burned in two cycle en-

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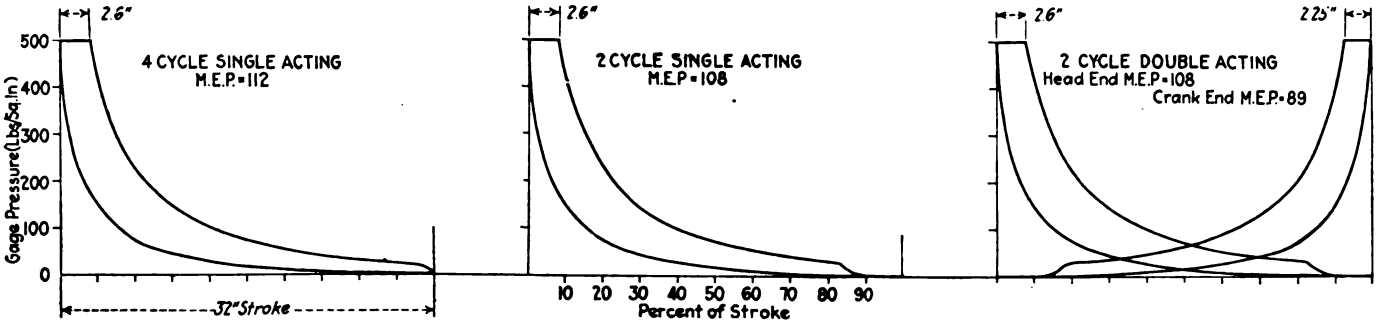

Fig. 26

gines, a fact which results from the absence of exhaust valves. The lubricating oil consumption of the double acting two cycle engine is less than that of the four cycle and approaches that of a steam engine of the same capacity, a

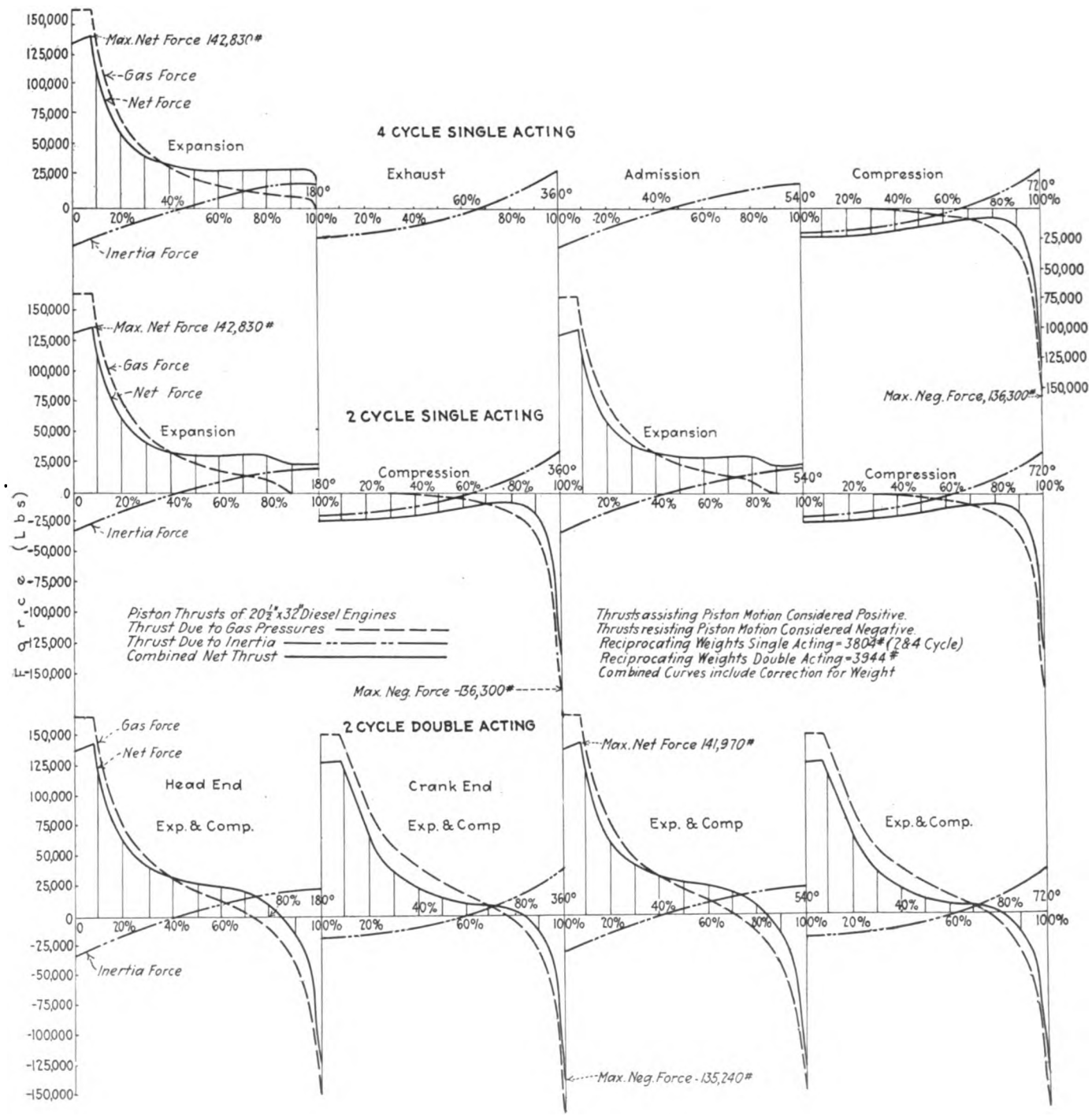

Fig. 27

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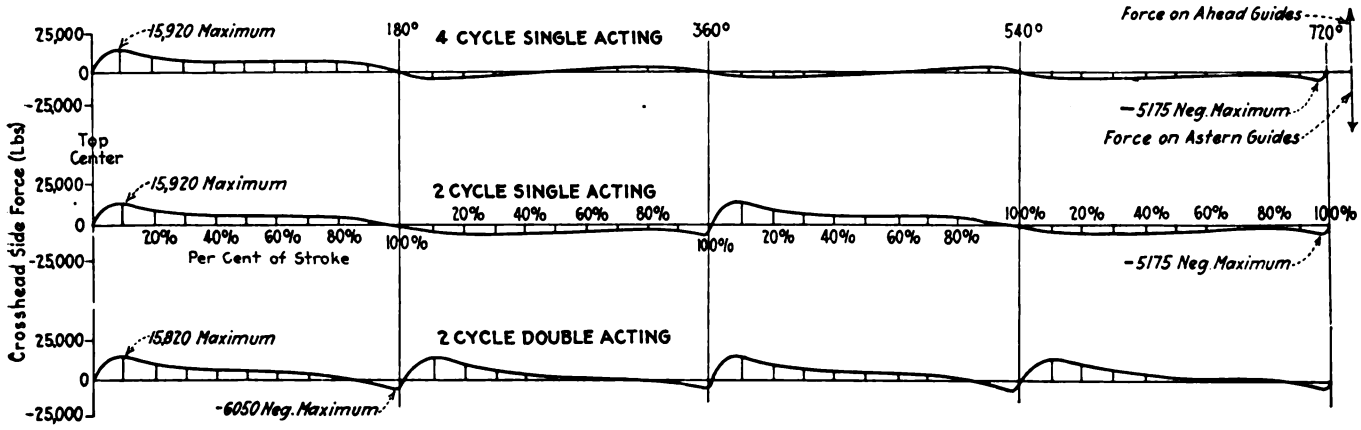

Fig. 28

saving which is due to the reduced dimensions and smaller number of moving parts.

SAVINGS IN SPACE AND WEIGHT AND COSTS

The most remarkable gain, however, is shown in the space and weight required and cost of manufacture, which readily explains itself from the fewness of parts and their greatly reduced size. The significance of this will be fully understood in the case of marine installations, where a three cylinder double acting two cycle engine can be put in the same space as a triple expansion steam engine of the same capacity and will not weigh as much as the latter with all its accessories; the entire space occupied by the boilers becomes available for cargo space. Thus, at a cost amounting to little more than that of a steam engine, it becomes possible to convert existing steamers into motorships without requiring extensive changes in the hull but resulting in a pronounced saving in cargo space and weight capacity. A logically constructed and installed double acting two cycle engine permits *new ships to be built at less cost than steamers and with an increase in cargo capacity equal to at least one-half the space and weight now required by first class steam equipment.* The rapid construction of such ships is greatly facilitated by the small number of engine parts and their relative simplicity which call for very much less machine shop and assembly work than single acting engines, a fact most convincingly expressed in the materially reduced manufacturing cost shown in Table II.

Nor do these gains from the manufacturing point of view exhaust the advantages of the double acting engine; an equally important gain can be scored from the viewpoint of operation. The greatly reduced number of moving parts, their extreme simplicity and all around accessibility are features which put this type of engine in a class by itself as regards convenience of operation. Not the least important point in this respect is the relative smallness, as compared with other types of engines, of the essential parts exposed to heat impulses, the cylinders, cylinder heads and pistons. Says Professor C. H. Peabody in MARINE ENGINEERING for September, 1920, page 754:

"The difficulty of cooling an internal combustion engine increases with the size in geometric ratio. As the thickness of the cylinder walls must increase with the diameter and the rate of flow of heat decrease with the cylinder volume, that is, with the cube of the diameter, the difficulty will increase in proportion with the fourth power, while the area of the surface increases only with the square. Consequently the difficulty of cooling increases with the square of the diameter of the cylinder; that is to say, it is four times as troublesome to cool a 200 horsepower engine as a 100 horsepower engine, for with constant piston speed and mean effective pressure, the power increases with the square of the diameter. Another way of looking at the matter is that with the same efficiency

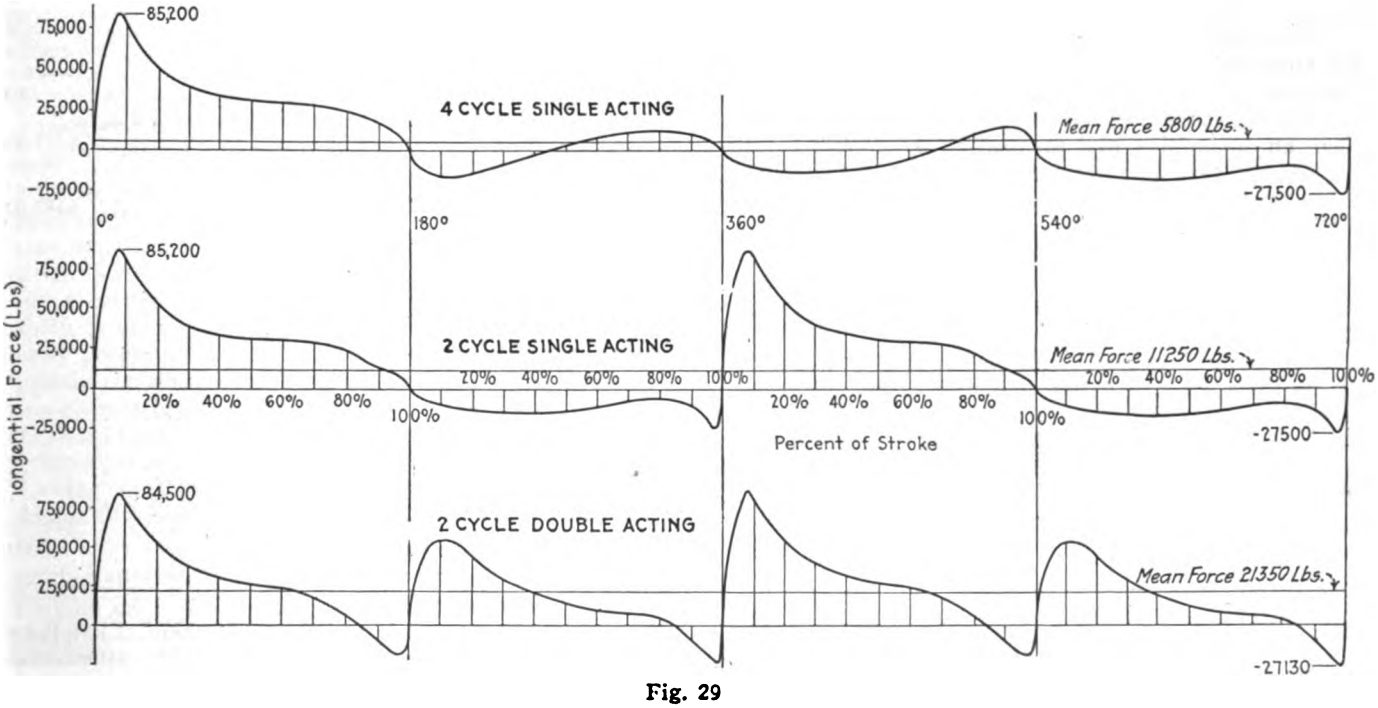

Fig. 29

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of cooling the inside of the cylinder will be hotter for the larger engine. This comes from the fact that a greater difference of temperature is required to force the heat through thicker walls. We must not be surprised that there is a tendency to reduce piston speed and mean effective pressure for large engines."

The foregoing exposition shows how systematic planning and logical adaptation have led to a system of Diesel engine construction which, while incorporating only well established constructional features and principles, opens an entirely new directive of enormous potentialities. Questions of fundamental importance, such as two cycle or four cycle and single acting or double acting, can be solved in the easiest possible and only proper manner—by accepting the legitimacy of either type in its proper application, which is primarily a matter of speed and to a lesser degree of size. The adoption of either type will involve but one capital change, that of the cylinder with the necessary parts, and will amount to a small fraction only of the cost of those parts which under this system remain unchanged. This is possible, as a critical study of the various views shows, without having to make any concessions whatsoever at the expense of any one type. Furthermore, all the constructional forms resorted to are sanctioned by the most advanced specialized experience and none of the incorporated features or combinations is novel in the sense of requiring extensive experimental research to establish its functional suitability.

Appendix

Force and Turning Moment Diagrams

Fig. 26 shows ideal indicator diagrams for four cycle and two cycle single acting engines and for the two cycle double acting engine. In plotting them the exponent 1.33 was used and a length of cut-off chosen such as to give the mean effective pressures marked. In the four cycle diagram, an initial absolute pressure of 14 pounds per square inch was assumed to exist at the bottom dead center position preceding the suction stroke. The compression curves for the two cycle engines were drawn on the assumption that absolute scavenging air pressure of 18 pounds per square inch is established in the cylinders at that point where the piston recovers the inlet ports. The toes of the two cycle diagrams have been faired out to a characteristic two cycle shape.

On the basis of these diagrams the curves in Fig. 27 were plotted. They show net forces acting along the cylinder centerlines corrected and uncorrected for inertia. Since the weights used for calculating the inertia forces were computed from finished detail drawings of the engine parts, no uncertainties of estimation need be allowed for. No investigations of the connecting rod side throw were made; instead of that, an assumption well justified by more exact calculations, namely, that 35 percent of the weight of the connecting rod parts is concentrated at the crosshead pin center and 65 percent at the crank pin center, has been made.

As will be noted, the inertia forces do not play as great a part as they would, for instance, in a twin tandem horizontal engine. In the figures for inertia weights given in the illustration, 3,804 and 3,944, respectively, only a small proportion (513 pounds) is due to the piston extension and produces an effect which is hardly discernible in the diagrams.

A natural progression in the material utilization already noted in the tables comparing horsepower weights and sizes is again manifest here. The four cycle piston thrust diagrams show a large proportion of idling. The two cycle diagrams exhibit a marked improvement in this respect and the ultimate utilization and work capacity that can be realized is represented by the double acting curves.

The crosshead side forces shown in Fig. 28 are small in proportion to the net piston thrusts. Owing to the effect of inertia in producing side pressure even during the idling periods of the four cycle engine, the mean crosshead thrust encountered in the double acting engine is by no means proportional to increased capacity. With the double center crosshead construction used on these machines, it is a simple matter to provide surfaces amply sufficient to resist the thrusts of the double acting crosshead without heating.

The most interesting curves of the series are the tangential effort curves shown in Fig. 29. The increase in uniformity and the rise in the mean value of these curves re-inforce the impression, already deepened by the observations hitherto made, that the natural climax of fitness and material efficiency is reached in the two cycle double acting engine. The mean tangential force of the four cycle engine is 5,800 and its ratio to the maximum is only .068. This ratio for the double acting two cycle engine amounts to .253, a figure which speaks for itself.

Efficiency in Material Handling

ONE of the pressing business questions of the day is the elimination of industrial wastes. It is a factor that has an important bearing on the manufacturer's problem of meeting present economic conditions.

Industrial waste may represent either material, labor or time. Material wastes are concrete, tangible and for this reason have received closer study. On the other hand labor wastes and time wastes, particularly unproductive labor and time represented in the handling of material, have not, generally speaking, received the attention their importance as a definite opportunity for effecting certain economy in manufacturing justifies.

The accurate records listed below were made by the Yale & Towne Manufacturing Company on the cost of handling 600 tons of molding sand, from a freight car on the railroad siding to the molding room in the foundry, 200 feet away. Forty feet of this distance was a 12 percent grade up a concrete ramp, with a sharp, right-angle turn into the shop at the top.

Mechanical Method

Material handled: Molding sand.	
From: Freight car.	
To: Molding room storage.	
Distance: 400 feet round trip.	
Grade: 12 percent—40 feet long.	
Capacity of Yale dump body truck: 27 cubic feet.	
Men required: To load	5
Men required: To unload	4
Men required: To operate	1
Total men	10
Total time consumed to unload shipment of 600 tons: 4 days.	
Total cost of labor (9-hour day)	$183.60
Demurrage charges	None
Total expense	$183.60

Wheelbarrow Method

Material handled: Molding sand.	
From: Freight car.	
To: Molding room storage.	
Distance: 400 feet round trip.	
Grade: 12 percent—40 feet long.	
Capacity of wheelbarrow: 5 cubic feet.	
Men required: To load	5
Men with wheelbarrows	13
Total men	18
Total time consumed to unload shipment of 600 tons: 6 days.	
Total cost of labor (9-hour day)	$495.72
Demurrage charges (over 4 days, $25 per day)	50.00
Total expense	$545.72

Many more examples could be cited. Mechanical handling is one way of accomplishing more work for the same expenditure.

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Problem of the Hull and Its Screw Propeller—IV*

Method of Estimating Effective Horsepower Delivered by a Propeller—Induced Cavitation—Wake Gain and Loss

By Rear-Admiral C. W. Dyson, U. S. N.

TO illustrate the method to be followed in making an estimate of the effective horsepower delivered by a propeller when the $I.H.P._d$ or $S.H.P._d$ and the speed of the vessel are known, take up the case of vessel *F*.

VESSEL F

Hull of the Dreadnought Type Having a Standard Basic Slip of Approximately 13 Percent

Propeller	
Number	4
Blades	3
Form	Standard
D	13.42′
P	15.17′
$\frac{P.A.}{\quad}$	.3567
$\frac{D.A.}{T.S.}$	7,760
$1 - S$	.86
V	23.97
$I.T._D$	4.97
$I.H.P.$	34,259 on four propellers
$P.C.$	.648
$E.H.P.$	22,200 on four propellers
$S.H.P.$	31,519 on four propellers

Ship steaming with one idle propeller on each side:

v	7	10	13.5	15
$\frac{v}{V}$	.292	.4172	.5632	.6258
$S.H.P._d$	1,760	4,443	9,263	11,586
Z_s (curve I, Fig. 6)	1.44	1.0	.62	.49
s	.3995	.3661	.3182	.295
R_d	77.87	105.4	132.3	142.1
Act. R_d	75.9	101.9	132.1	143.85
$S.H.P.$	15,760	15,760	15,760	15,760
K	1	1	1	1
$\frac{e.h.p._1}{E.H.P.}$ for $\frac{v}{V}$	.06	.122	.33	.545
Z_1	1.25	.94	.5	.27
Z_p	1.101	.745	.365	.202
$e.h.p. \div E.H.P.$	.105	.192	.442	.635
$e.h.p.$	1,166	2,131	4,910	7,050

In the above calculations

$$2Z_p = \log S.H.P. - \log S.H.P._d + Z_1.$$

It has been stated that with vessels of types 1 and 3 the transposition of Z_s from curve 1 to 2, Fig. 7 (see page 400, May issue), does not occur. This statement requires modification because it does happen when what may be called induced cavitation occurs. By this term is meant cavitation which is produced by means other than the conditions normally governing the performance of the propeller. It is frequently encountered with vessels of the destroyer type when propeller struts have been so constructed and fitted as to increase the squat of the hull and to produce areas of reduced pressure in the wake of the struts, the propellers working in these areas. In such cases the value of Z_s gradually passes over from curve 1 to curve 2, the departure from curve 1 for vessels of 310 feet load waterline length occurring approximately at a speed $v = 1.42\sqrt{L.L.W.L.}$ and arriving on curve 2 when $v = 1.92\sqrt{L.L.W.L.}$

To illustrate this phenomenon the case of a destroyer is given in which the shafts were carried by two struts each, the axis of the lower arm of each forward strut being parallel to the base line of the vessel, while the axes of the lower arms of the after struts were inclined downward at the forward edge 4½ degrees.

VESSEL G

Hull		*Propeller*	
$L.L.W.L.$	= 300.5′	Number	2
B	= 30.5′	Blades	3
H	= 9.583′	Form	Standard
$\frac{B}{L.L.W.L.}$	= .1015	D	92.5″
		P	82″
Nom. $B.C.$	= .428	$\frac{P.A.}{\quad}$	.595
$\frac{H}{B}$	= .314	$\frac{D.A.}{T.S.}$	13,330
$L.A.B.$	= 150.25	$P \times R$	3,762
$\frac{2L.A.B.}{H}$	= 31.35	$1 - S$	.79
		V	29.33
$B.C.$ on $C - D$	= .345	$I.T._D$	11.77
$B.C.$ on $C - D$ cor. for $\frac{H}{B}$	= .271	$I.H.P.$	18,021
		$P.C.$	.525
		$E.H.P.$	9,461
		$S.H.P.$	15,680

$S.B.C.$ on $\frac{X}{S}$ = .315 / .21

$v_1 = 1.42\sqrt{300.5} = 24.75$

$v_2 = 1.92\sqrt{300.5} = 33.44$

$\frac{v_1}{V} = .85$

$\frac{v_2}{V} = 1.279$

Z_s taken on straight line passing over from $\frac{v_1}{V}$ on curve 1, Fig. 7, to $\frac{v_2}{V}$ on curve 2; where curve of $\frac{e.h.p.}{E.H.P.} - \frac{v}{V}$ crosses ordinate of unity load at lower than $\frac{v}{V} = 1$ (Fig. 8), curve 2 becomes a horizontal line coinciding with $Z_s = 0$, Fig. 7. The change of the Z_s condition does not change so abruptly as is done in making the estimate, for

*Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1920.

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e. h. p. / E.H.P.	e. h. p.	v	$\frac{v}{V}$	Zp	K	S. H. P.d Est.	S. H. P.d Act.	Zs	S	s	Revs. Est.	Revs. Act.
.025	237	10.3	.3512	—1.668	1	356	400	+1.215	.21	.074	165	160
.05	474	12	.4092	—1.355	1	732	720	+1.025	.21	.09823	197.3	200
.075	711	14.3	.4877	—1.1715	1	1,117	1,150	+ .805	.21	.09093	233.3	230
.10	946	15.52	.5292	—1.0414	1	1,507	1,500	+ .70	.21	.09568	254.5	252
.20	1,892	19.25	.6564	— .7279	1	3,102	3,100	+ .435	.21	.1070	319.7	317
.30	2,838	21.5	.7332	— .5445	1	4,732	4,750	+ .30	.21	.1196	362.1	359
.40	3,785	22.8	.7775	— .4144	1	6,385	6,300	+ .248	.21	.1432	394.6	394
.50	4,730	24	.8184	— .3135	1	8,055	8,100	+ 1.65	.21	.1492	418.3	425
.60	5,676	25.1	.8559	— .231	1	9,741	9,700	+ .122	.21	.1634	444.9	453
.70	6,623	26.15	.8917	— .1613	1	11,436	11,500	+ .105	.21	.1845	475.5	476
.80	7,570	27.15	.9258	— .1009	1	13,143	13,100	+ .095	.21	.2072	507.8	508
.90	8,514	28.15	.9599	— .0477	1	14,855	14,900	+ .08	.21	.2227	540.5	538
1.00	9,461	29.2	.9957	0.0	1	16,580	16,550	+ .061	.21	.2417	571	571
1.05	9,935	29.94	1.021	+0.0221	1	17,445	17,400	+ .05	.21	.2479	590.3	591

inspection of the actual revolutions indicates that it begins at about 23 knots and changes gradually until at 26 knots it has taken its position on the pass-over line used in the estimate.

CAVITATION WHEN $\frac{e.h.p.}{E.H.P.}$ IS GREATER THAN UNITY

When the load fraction exceeds unity the laws governing the action of the propeller, both as to power and apparent slip increments, appear to change, but the changes occurring appear to be dependent upon the value of the speed fraction at which the performance plots on Fig. 8 (see page 402, May issue).

Should the performance plot on or above the curve E, Fig. 8, and at a load fraction exceeding unity, the values of Z_p follow the curve marked 5 on Fig. 7, while should it plot below the curve E the value Z_p follows the curve 4, the equation for curve 4 being

$$Z_p = 1.0414 \log \left(\frac{e.h.p.}{E.H.P.} \right)$$

while that for curve 5 is

$$Z_p = 1.51 \log \frac{e.h.p.}{E.H.P.}$$

Should the performance plot above E, the values of Z_s follow the curve 3, which differs slightly in equation from the cavitation curve 2, Fig. 7, the new equation being

$$Z_s = 3 \log \left(\frac{v}{V} \right)$$

I, a reciprocating engine destroyer plotting above E; vessel J, a destroyer plotting below E; vessel K, a dreadnought plotting below E.

The trial data of vessels I and J are not of the best, as the propellers of I were cavitating heavily, producing excessive vibration of the engines and affecting the clearness of the indicator cards, while with vessel J the starboard propeller and torsion meter readings suffered badly through induced cavitation of that propeller, the port propeller running smoothly.

VESSEL H—TYPE 1

Hull		*Propeller*	
$L.L.W.L.$	= *	Number	2
B	= *	Blades	3
H	= *	Form	Standard
$B \div L.L.W.L.$	= .167	D	18.25′
Nom. $B.C.$	= .6	P	19.75′
$B.C.$ on $C - D$	= .572	$P.A. \div D.A.$	.328
$\frac{H}{B}$	= .317	$T.S.$	7,250
$B.C.$ on $C - D$ cor. for $\frac{H}{B}$	= .492	$P \times R$	2,498
Slip $B.C.$ on X	= .525	$1 - S$	8.65
$L.A.B.$	= *	V	21.32
$2L.A.B. \div H$	= 18.88	$I.T.D.$	4.35
S	= .135	$I.H.P.$	24,800
K	= 1	$P.C.$	.665
		$E.H.P.$	16,492

*The data omitted are confidential and therefore cannot be made public.

e. h. p. / E.H.P.	e. h. p.	v	$\frac{v}{V}$	Zp	I. H. P.d Est.	I. H. P.d Act.	Zs	S	s	Revs. Est.	Revs. Act.
.0747	1232	9.5	.3896	—1.1718	1670	1600	+1.09	.135	.1118	49.1	52
.09957	1642	10.45	.4902	—1.042	2251	2200	+ .8	.135	.07742	58.12	57.5
.1991	3284	13.21	.6196	— .728	4639	4800	+ .502	.135	.08023	73.69	73.6
.2987	4926	15.05	.7059	— .545	7054	7125	+ .346	.135	.08538	84.43	84.5
.3983	6568	16.45	.7716	— .415	9538	9300	+ .235	.135	.08919	92.66	92.5
.4978	8210	17.7	.8302	— .314	12035	11600	+ .145	.135	.09148	99.96	99.75
.5974	9852	18.92	.8875	— .233	14503	14625	+ .07	.135	.09275	107	106.8
.697	11494	19.76	.9269	— .1615	17098	17200	+ .017	.135	.09679	112.3	112.1
.7965	13136	20.33	.9536	— .1012	19645	19600	+0	.135	.1069	116.8	116.2
.8961	14778	20.8	.9756	— .048	22205	22200	+0	.135	.1209	121.4	120.2
.9957	16420	21.24	.9963	— .001	24740	25200	+0	.135	.1347	125.9	124.8
1.045	17230	21.44	1.006	+ .0294*	26537	26600	+ .015	.135	.1396	127.9	126.5
1.095	18062	21.62	1.014	+ .056*	28213	28100	+ .023	.135	.1457	129.9	129.2

Should it plot below E, the values of Z_s for values of $\frac{v}{V}$ greater than .9385, becomes zero, the increase in apparent slips being apparently independent of speed but entirely dependent upon power.

PERFORMANCES OF FOUR VESSELS ANALYZED

In order to illustrate these phenomena the performances of four vessels will be analyzed, the first, vessel H, having been used in the preparation of all the design curves; vessel

The next vessel given is extremely interesting on account of the enormous range of load fraction and large range of speed fraction through which the performance extends.

VESSEL I—TYPE 2

Hull		*Propeller*	
$L.L.W.L.$	= 245′	Number	2
B	= 23.52′	Blades	3
H	= 6.687′	Form	Standard
$B \div L.L.W.L.$	= .096	D	7.42′
Nom. $B.C.$	= .41	P	10.833′
$B.C.$ on $C - D$	= .332	$P.A. \div D.A.$	.275
$H \div B$	= .284	$T.S.$	6,400

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B.C. on *C* — *D* cor.		*P* × *R*	2,974
H		1 — *S*	.7775
for ——	= .247	*V*	22.82
B		*I.T.D*	3.23
S.B.C. on *X*	= .295	*I.H.P.*	3,625
2*L.A.B.*	= 245	*P.C.*	.693
2*L.A.B.* ÷ *H*	= 36.64	*E.H.P.*	2,512
S	= .2225		

*In this case Z_p follows curve 5, Fig. 7, and Z_s follows curve 3.

sequent reduction of pressure occurs an increase in wake over the normal is generally encountered, resulting in a slowing down of actual revolutions below the estimate. The tip speed of the propeller at 35 knots was 16,050 feet with an effective thrust per square inch of projected area of 16.9 pounds, both figures being exceptionally high.

VESSEL K

This vessel is of the dreadnought type and has propellers

	v		e. h. p.		I. H. P.d		VESSEL H—TYPE 1			Revs.	
v	*V*	e. h. p.	E. H. P.	*Zp*	Est.	Act.	*Zs*	*S*	*s*	Est.	Act.
16	.7013	467	.1859	—.762	627	....	+.35	.2225	.08617	163.8	...
18	.789	787	.3133	—.522	1090	....	+.21	.2225	.1085	188.9	184
20	.8767	1287	.5123	—.298	1825	....	+.082	.2225	.1353	216.4	220
22	.9643	1978	.7874	—.105	2847	2750	+.0	.2225	.1747	249.4	255
24	1.052	2881	1.147	+.09	4460	4500	—.07	.2225	.233	292.6	296.5
25	1.096	3297	1.313	+.18	5487	5500	—.122	.2225	.2543	313.6	313.5
26	1.14	3738	1.488	+.26	6597	6500	—.178	.2225	.2687	332.6	324
27	1.184	4193	1.669	+.34	7931	7600	—.226	.2225	.2893	355.4	342
28	1.227	4474	1.781	+.38	8696	8750	—.278	.2225	.2814	364.5	368
28.5	1.249	4622	1.84	+.4	9106	9300	—.3	.2225	.2801	370.3	374

The performance of this vessel's propellers enters the overload zone to a greater extent than any other of which the records are available. The maximum load fraction attained is 1.84, while the corresponding speed fraction is 1.249. The ratio *S.H.P.* = .92 *I.H.P.* probably does not exactly fit this case, as the main air pumps were driven by the main propelling engines and absorbed some of the power developed by those engines.

VESSEL J

This vessel is a destroyer fitted with turbines connected directly to the propeller shafts. The revolutions are high with resultant high tip speeds, while the effective thrusts delivered at 35 knots were also very high. The blades of the starboard propeller had been injured by striking something and were run in this injured condition, with the result that the performance of this propeller was extremely erratic. The port propeller, however, ran smoothly to the end of the trials and the power data taken from this shaft were consistent. In comparing the estimated and actual performances the actual power of the port shaft has been doubled for the total power, while the revolutions of that shaft have been taken as the normal revolutions.

Hull		*Propeller*	
L.L.W.L.	= 310′	Number	2
B	= 30.7′	Blades	3
H	= 9.146′	Form	Standard
B ÷ *L.L.W.L.*	= .99	*D*	7.8′
Nom. *B.C.*	= .476	*P*	7.42′
H ÷ *B*	= .298	*P.A.* ÷ *D.A.*	.648
S.B.C. on *X* (cor.)	= .285	*T.S.*	15,100
2*L.A.B.* ÷ *H*	= 33.89	*P* × *R*	4,572
S	= .222	1 — *S*	.778
		V	35.11
		I.T.D	13.65
		I.H.P.	26,025
		P.C.	.525
		E.H.P.	13,663
		S.H.P.	23,943

of such characteristics as to plot her performance considerably below curve *B*, Fig. 8. Her hull is of type 1.

Hull		*Propeller*	
L.L.W.L.	= *	Number	4
B	= *	Blades	3
H	= *	Form	Standard
B ÷ *L.L.W.L.*	= .168	*D*	9.583′
Nom. *B.C.*	= .622	*P*	8.193′
B.C. on *C* — *D*	= .586	*P. A.* ÷ *D.A.*	.501
H ÷ *B*	= .305	*T.S.*	10,670
B.C. on *C* — *D* cor.		*P* × *R*	2,904
H		1 — *S*	.84
for ——	= .455	*V*	24.13
B		*I.T.D*	8.75
S.B.C. on *X*	= .49	*I.H.P.*	31,732
2*L.A.B.* ÷ *H*	= 19.5	*P.C.*	.554
S	= .16	*E.H.P.*	17,580
K.B.C.	= .612	*S.H.P.*	29,196
Mean *T.C.*	= Large		
K	= 1		

* The data omitted are confidential and therefore cannot be made public.

Concerning the efficiency of propulsion, results of trials indicate that with type 1 and probably very fine type 3 ships, where the basic slip is greater than the *S* values corresponding to curve *B*, Fig. 8, there is a gradual increase in efficiency in passing from the upper curve of *S* to *B* and then a gradual decrease until the cavitating curve for the basic *S* is reached. However, in making the estimates of performance this probable increase should be omitted and carried as so much possible velvet. The maximum gain is probably reached with basic slip between 21 and 22 percent, becoming practically zero with those basic slips for which the upper *S* curves on Fig. 8 approximate closely to *B* or are below *B*.

WAKE GAIN AND LOSS

Before taking up the subject of design there is one phenomenon met with to which attention should be called, and this is the effect produced by a change of wake which may

		v	e. h. p.			ANALYSIS S. H. P.d					Rs	
v	e. h. p.	*V*	E. H. P.	*Zp*	*K*	Est.	Act.	*Zs*	*S*	*s*	Est.	Act.
12	430	.3418	.03147	—1.53	1	707	800	+1.255	.222	.1179	185.7	184
16	1050	.4558	.07685	—1.14	1	1735	1800	+ .894	.222	.1260	249.9	249.9
20	2210	.5697	.1618	— .82	1	3624	3900	+ .62	.222	.1401	317.4	310
24	4700	.6837	.3440	— .481	1	7910	8300	+ .388	.222	.1792	399.1	389
28	8600	.7976	.6294	— .205	1	14934	15000	+ .2	.222	.2195	489.6	468
32	12970	.9115	.9493	— .0221	1	22755	23000	+ .032	.222	.2271	565.1	563
34	15100	.9685	1.105	+ .0632	1	27695	27500	+ .0	.222	.2594	626.6	623
35	16200	.997	1.186	+ .80	1	28953	29400	+ .0	.222	.2669	652	655

These vessels begin squatting at about 20 knots, and when the struts are properly located so that no eddying with con-

occur due to the vessel altering her lines of flotation. This variation of wake may be due to a change in trim, causing

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ANALYSIS

e. h. p. / E. H. P.	e. h. p.	v / L	v / V	Zp	K	S. H. P.$_a$ Est.	S. H. P.$_a$ Act.	Zs	S	s	Revs. Est.	Revs. Act.
.1	1758	10.31	.4273	—1.0414	1.0	2654	2750	.98	.16	.139	148	153
.2	3516	12.96	.5371	— .7279	1.0	5463	5400	.68	.16	.143	187	189.5
.3	5274	14.81	.6138	— .5445	1.0	8333	8100	.515	.16	.149	215	218
.4	7032	16.3	.6755	— .4144	1.0	11244	11050	.400	.16	.158	240	241
.5	8790	17.44	.7228	— .3135	1.0	14185	13700	.317	.16	.161	257	259
.6	10548	18.42	.7634	— .231	1.0	17152	16300	.250	.16	.167	274	274.5
.7	12306	19.32	.8007	— .1613	1.0	20138	19150	.19	.16	.171	288	288.5
.8	14064	20.1	.8350	— .1009	1.0	23143	22000	.142	.16	.176	302	302.5
.9	15822	20.7	.8579	— .0477	1.0	26159	25300	.11	.16	.185	314	315
1.0	17580	21.13	.8757	— .00	1.0	29196	28300	.082	.16	.193	324	326
1.05	18459	21.3	.8848	+ .0221	1.0	30720	30000	.075	.16	.200	329	331.5

an increase in wake during a portion of her career, but the wake usually returning to normal after an upper limiting speed is attained, or it may be caused by the vessel lifting bodily in the water, decreasing its submerged fullness and tending to plane. This latter action is accompanied by a heavy decrease in wake and a corresponding falling off in efficiency in propulsion.

EFFECT OF ALTERED TRIM

Vessels which slightly alter their trim at a speed depending upon the ratio of v to $\sqrt{L.L.W.L.}$ may accomplish this change in trim without an increase in the wake. Such a vessel is vessel *H*, while another ship of similar type may show a decided gain in efficiency during this period of increased wake due to the resulting increased thrust of the propeller produced by the increase in wake. Such a gain is spoken of as wake gain. Such gain is shown by vessel *L*, following. Vessels *H* and *L* have effective horsepower curves practically identical in form. Both show a slight hump between 15 and 17 knots. The performances on trial of the two ships were radically different. The writer was aboard both of these vessels and noted that vessel *H*, which was the lighter and smaller of the two ships, after passing 15 knots developed a very peculiar vertical vibration which gave one the impression that she was trying to break her back. This vibration disappeared after passing 17 knots. Vessel *L*, on the contrary, passed through the range of the hump smoothly and with a total lack of this peculiarity of vibration. Analysis of the performance of vessel *L* shows that when the estimate of power and revolutions are made for the speeds and effective horsepowers obtained from the model tank the revolutions obtained agree with the revolutions corresponding to the actual speeds corresponding to these estimated powers.

When a vessel lifts bodily in the water and begins planing as she lifts, the model tank curves indicate a rapid decrease in the increment of increase of the resistance. Should the estimate of power required be made for the *e.h.p.* and speed given on this curve of deflection, a bitter disappointment will be encountered. Rather, the curve before inflection should be extended by means of a batten and the v's corresponding to this extended curve of *e.h.p.* will be the actual speeds obtained by using the model tank curve of *e.h.p.* and v. After planing is accomplished the wake gradually increases to normal as the speed is increased.

Gain by possible wake increase should never be counted on as a certainty, but loss by wake decrease should always be allowed for.

VESSEL L

In the case of this vessel, the estimated powers and revolutions are those obtained from the model tank curve, while there are also given columns of the actual *S.H.P.*$_a$, speeds with corresponding revolutions obtained by fairing the hump out of the model tank curve and using the new speeds as those to be expected rather than those used in the estimate.

DESIGN OF THE PROPELLER

In treating this subject an attempt will be made to be as

CONDITION I

Hull		*Propeller*	
L.L.W.L. =	*	Number	4
B =	*	Blades	3
H =	*	Form	Standard
B ÷ *L.L.W.L.* =	.162	*D*	12.863′
Nom. *B.C.* =	.646	*P*	11.209′
B.C. on *C* — *D* =	.595	*P.A.* ÷ *D.A.*	.4247
H ÷ *B* =	.297	*T.S.*	9,000
B.C. on *C* — *D* cor.		*P* × *R*	2,502
H / *B* for	= .455	1 — *S*	.865
		I	21.61
S.B.C. on *X* =	.49	*I.T.p.*	6.62
L.A.B. =	*	*I.H.P.*	37,404
2*L.A.B.* ÷ *H* =	20.82	*P. C.*	.603
S =	.135	*E.H.P.*	22,556
M.T.C. =	Large	*S.H.P.*	34,412
K =	1		

*The data omitted are confidential and therefore cannot be made public.

ANALYSIS

e. h. p. / E.H.P.	e. h. p.	v / tank	v / V	Zp	K	S.H.P.$_a$	v_1 faired	S.H.P.$_d$ for v_1	Zs	S	s	R_a Est.	R_a Act. for v_1
.1	2256	11	.5091	—1.0414	1	3128	11.25	3250	+ .75	.135	.069	106.8	102
.2	4512	13.86	.6415	— .7279	1	6439	14.0	6550	+ .46	.135	.0729	135	129.6
.3	6768	15.75	.729	— .5445	1	9822	16.12	8950	+ .305	.135	.0778	154.4	151.3
.4	9024	17.25	.7984	— .4144	1	13253	17.67	13200	+ .198	.135	.082	169.9	168
.5	11280	18.4	.8517	— .3135	1	16719	18.8	16750	+ .118	.135	.0861	182	181.7
.6	13536	19.3	.8933	— .231	1	20217	19.7	20300	+ .061	.135	.0913	192	190.6
.7	15788	20.05	.928	— .1613	1	23736	20.34	23700	+ .015	.135	.0964	200.6	198.6
.8	18048	20.7	.9581	— .1009	1	27278	20.85	27250	0	.135	.107	209.6	206
.9	20304	21.15	.9789	— .0477	1	30833	21.25	31100	0	.135	.1131	215.6	213.5
1.0	22556	21.45	.9928	0	1	34412	21.55	Off curve	0	.135	.135	224.2	221

brief as possible, confining the discussion entirely to the precautions that must be taken in deciding upon the initial point of the design and to the formulas used in obtaining the design. This subject will be discussed in the fifth installment of this article, which will appear in the August issue.

(To be continued.)

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Balsa Insulation for Refrigerator Ships

Overcomes Many Difficulties in Installation and Maintenance of Refrigerated Spaces—Standard Insulation Plans

INSULATION that is adequate and economical in operation and practical from the viewpoint of the shipbuilder and the shipowner is one of the most important factors in the development of refrigerator ship cargo capacity for the transportation both of fruits and of the more highly perishable meat and dairy products.

In the fruit trade there are several interesting developments along new lines, the more important being the movement of Pacific Coast fruits to the Atlantic via the Panama Canal. Heretofore practically all of this tonnage has moved overland but the burden of greatly increased freight rates and the improved service by water in point of time and frequency of sailing are responsible for the recent experimental shipments of citrus fruits and apples by water. The fruit growers are now carefully studying various methods of insulation and refrigeration in co-operation with the Department of Agriculture. Projects are also under consideration for the movement of fancy fruits from the west coast of South America to the United States.

With the exception of the fruit trade, both existing and under development, the United States, though the largest producer of foodstuffs in the world, has not felt the necessity of having refrigerator ships to carry abroad its surplus of perishable meat and dairy products. This condition may partly arise from what is apparently the belief of ship operators that refrigerated ships are undesirable from the viewpoint of maintenance and upkeep and that they are not adaptable to general cargoes on the return hauls; despite the fact, too, that cargo carrying under refrigeration brings higher freights rates and permits of more complete service.

The demand for refrigerated cargo vessels divides between two principal groups of products—meats, requiring low temperatures, and fruits, calling for temperatures of 35 to 50 degrees F. In the meat trade, home consumption demands have established England as the chief importer of frozen and chilled meat, to the extent that in 1913 that country took 94 percent of the total world tonnage of these products moving over seas. To bring these meats from her colonies and from South America, England has developed a great fleet of refrigerator vessels representing in 1920 about 75 percent of the total refrigerator ship capacity of the world. If the refrigerator space in the large passenger liners is excluded, English ships have over 90 percent of the world's refrigerated cargo capacity. This world capacity aggregated, in 1913, 53,000,000 cubic feet of cold storage space in ships having 10,000 or more cubic feet each, excluding the fruit carriers. By June, 1920, this figure had increased, almost proportionately with the increased meat trade, to 89,000,000 cubic feet, including the capacity of ships under construction.

The difficulties of maintenance and flexibility center largely around the problem of satisfactory insulation of the refrigerated spaces. That many of these difficulties can now be avoided through the use of Balsa insulation, gives promise of a more extended interest in this type of tonnage. For example, with the formerly accepted methods of insulation it was impossible to get at the shell of the vessel to locate and repair a leaking rivet without tearing out the insulation and having to patch it up one way or another afterwards. Or in such a case as a slight collision with the dock or tug boat nose, or other damage, the exact point which must be inspected is often difficult to locate and considerable areas must therefore be uncovered to find the exact location of the trouble, even though this may be quite small and trivial.

Another point in connection with many forms of insulation is that, while they are efficient when dry as first installed, they gradually absorb moisture and lose their insulating value or they may shake down under the vibration of the ship. Renewal expense is therefore a large item in these cases. Balsa thoroughly treated and waterproofed retains its insulating efficiency and its structure.

Balsa insulation, now in use on over sixty vessels and specified for another twenty odd under construction according to a tabulation prepared by American Balsa Company, Inc., is in distinct contrast with other insulating materials. Probably the most important development in the use of Balsa is the plan of installation which permits the ready removal of entire sections of the insulation for the repair or painting or simple inspection of the ship's hull. These sections can quickly be lifted back into place without sacrifice to the insulating efficiency of the structure and without any waste of material. The importance of this plan will at once be appreciated.

Other factors such as durability and permanence, high insulating quality, ease of installation and saving of space and weight make a consideration of Balsa of interest. Equally, too, does the present extension of its use to the insulation of boiler and engine room casings, crew's quarters and for partitions between staterooms.

Balsa is the lightest weight wood known to commerce, averaging in its treated condition about ten pounds per cubic foot, or roughly, one-third less than cork. Individual pieces of Balsa have been found weighing as little as four pounds per cubic foot. This lightness results from its peculiar cellular structure which is said to differ from that of any other wood. In ordinary wood the thickness of the cell walls forms a considerable part of their diameter. In Balsa these walls are extremely thin and, where in other woods these are woody fibers, there is in Balsa practically no lignification. This structure confines within its large, barrel shaped cells a quantity of "dead" air, i.e. non-circulating air, representing over 90 percent of the total volume of the wood, accounting for its high insulating value.

In contrast with any other insulating material Balsa has the important and unique advantage of a structural strength which is fully half that of spruce. This strength of Balsa, together with its other advantages of woodworking facility, the large panels in which it is supplied, tight joints, non-absorption of moisture and permanence of structure, establish an entirely new basis for the installation of insulating material. Balsa panels are 24 inches wide, 8 feet to 10 feet in length and 1 inch, 2 inches and 3 inches in thickness. This large size is an important factor in the simplicity of its installation.

Irrespective of the coefficient of heat transmission of the insulating material, the refrigerating engineer has always found it necessary to allow an excessive margin for joint leakage because of the difficulty of securing tight joints under the conditions of commercial installation and because of the

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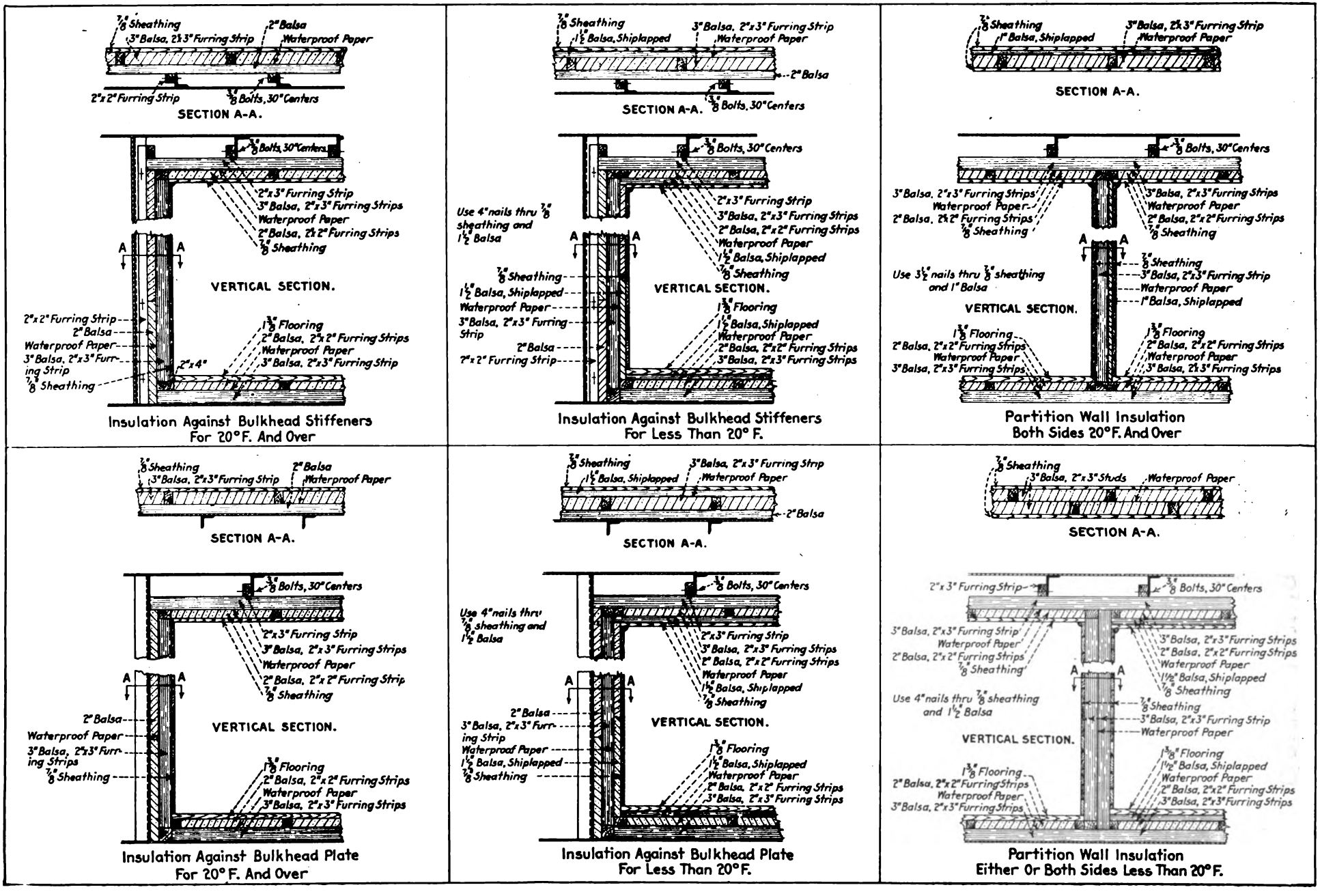
7/8" Sheathing
3" Balsa, 2"x3" Furring Strip
2" Balsa
Waterproof Paper
2"x2" Furring Strip
3/8" Bolts, 30" Centers
SECTION A-A.
2"x3" Furring Strip
3" Balsa, 2"x3" Furring Strips
Waterproof Paper
2" Balsa, 2"x2" Furring Strips
VERTICAL SECTION.
1 3/8" Flooring
3" Balsa, 2"x3" Furring Strip
2"x4"
Insulation Against Bulkhead Stiffeners
For 20° F. And Over
1 1/2" Balsa, Shiplapped
Use 4" nails thru 7/8" sheathing and 1 1/2" Balsa
Insulation Against Bulkhead Stiffeners
For Less Than 20° F.
1" Balsa, Shiplapped
Use 3 1/2" nails thru 7/8" sheathing and 1" Balsa
Partition Wall Insulation
Both Sides 20° F. And Over
Insulation Against Bulkhead Plate
For 20° F. And Over
Insulation Against Bulkhead Plate
For Less Than 20° F.
3" Balsa, 2"x3" Studs
Partition Wall Insulation
Either Or Both Sides Less Than 20° F.

Fig. 1.—Standard Balsa Insulation Plans for Refrigeration

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higher heat transmission of the cementing or filling materials that have ordinarily to be used. It is also necessary with other materials to compensate for loss of efficiency through moisture absorption.

Balsa, with a coefficient that compares favorably with other commercial materials, has the added advantage of very small joint leakage. This is due, first, to the smaller number of joints possible with the large panels and, second, to the close woodworking of the tongue and groove, ship lap or butt joints used and the elasticity of the wood which permits of very tight setting of these joints.

Another important factor resulting from the structural character of the Balsa panels is the elimination of most of the sheathing, studding and supporting structure required where other insulating materials are used. Instead of a large number of layers of waterproof paper, sheathing and framing necessary to support the insulating material proper, there is required with Balsa only one layer of sheathing for protection against surface wear.

This simplified construction represents an important

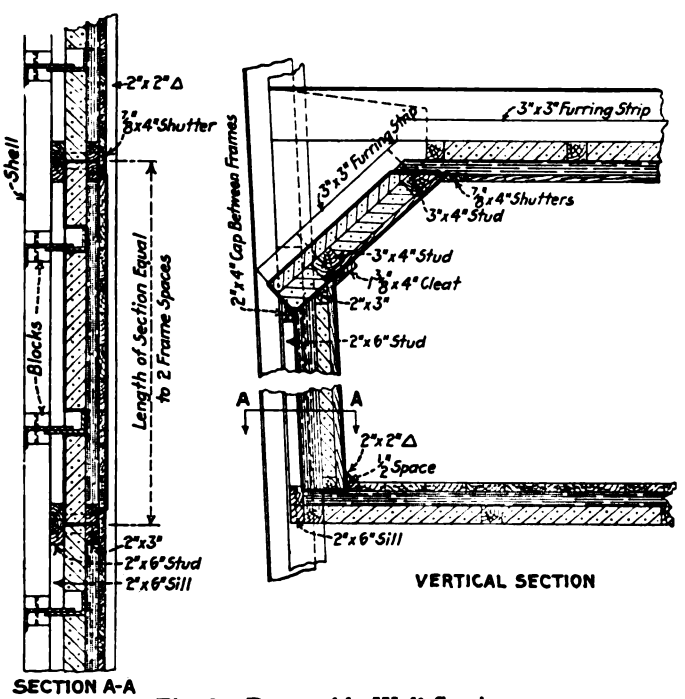

Fig. 2.—Removable Wall Sections

saving both in the cost of the accessory materials and in the labor of assembling; together with the light weight of the Balsa itself, it also materially reduces the deadweight which must be carried and the saving in total thickness of the insulation wall or floor means just so much greater revenue-producing storage capacity. For example, a completed insulation wall, using six inches of cork board with the required four layers of spruce sheathing, is 9 inches thick and weighs 17 pounds per square foot of wall area. Six inches of Balsa insulation, with the one protecting layer of spruce needed, is 7½ inches thick and weighs only 8 pounds per square foot, or less than half the weight.

One of the most important features of Balsa is the permanence of its structure and insulating value, achieved through special treatments to which the wood is subjected. It is by reason of these exclusive methods of treatment that the American Balsa Company has been successful in adapting this product of the tropical forests to the many practical commercial uses to which Balsa is being placed.

The processes of treatment expel all surplus moisture from the wood and preserve it against decay. In addition, the waterproofing treatment effectively prevents the absorption of moisture after installation. Balsa, therefore, is not subject to a reduction of insulating efficiency; and from the viewpoint of sanitation, this exclusion of moisture absorption by Balsa is a valuable feature through the prevention of odors arising from bacterial lodgment and growth.

By reason of its many desirable characteristics, Balsa is meeting successfully the problem of maintaining permanent insulating efficiency in refrigerated spaces on board ship. Where many other materials quickly deteriorate through the absorption of moisture and disintegrate or become dislocated through vibration, Balsa has been found to maintain its structure and efficiency even under the most unfavorable conditions.

STANDARD INSULATION PLANS

The extensive employment of Balsa as the insulating material for ships has led to the adoption of a series of standard plans of installation for different locations and different

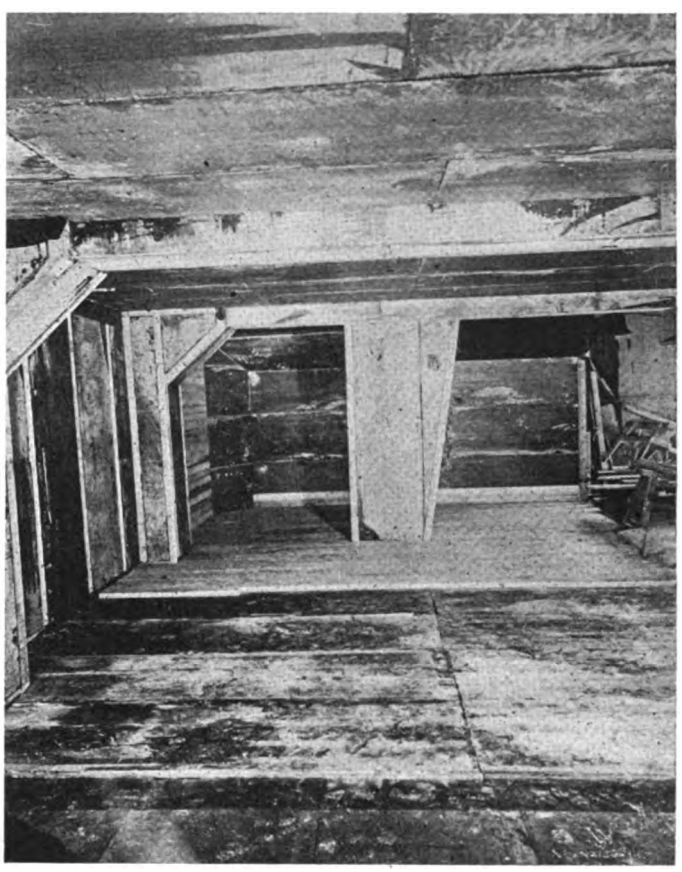

Fig. 3.—Several Stages of the Installation of Balsa Ship Insulation in Refrigerated Cargo Hold of Passenger and Cargo Liner

types of ship construction and for temperatures above or below 20 degrees F. Where abnormal conditions prevail these plans can easily be modified. Sketches of these plans are shown in Figs. 2-7, which indicate the simplicity of Balsa installation. Standard instructions covering the details of erection have also been issued, which place the whole installation within the scope of ordinary joiner work.

Particular interest attaches to the plan of installation, already mentioned, by which the insulating walls can be removed to get at the shell of the ship. Heretofore, when it has been found necessary to paint or inspect the inside of the hull or to replace rivets, the insulating material has had to be torn out and, later, patched up at the expense of insulating efficiency and a great deal of labor.

REMOVABLE WALL SECTIONS

With the plan of Balsa insulation shown in Fig. 2, the removable wall sections are made of one layer of Balsa

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panels erected vertically and another layer laid horizontally, enclosed in a hardwood frame to which the sheathing is applied vertically. These composite sections are held in place by fastening the frame to stationary studs with lag screws. The heads of the screws are covered by a 4 inch shutter of the sheathing material running the length of the joint. Under this plan of construction there is a continuous layer of the insulating material, a most important factor in efficient insulation. Furthermore, all of the joints surrounding the removable section are broken, thereby preventing air leakage.

To take out any section of the Balsa removable insulation the shutter on each side of the section and the top and bottom cleats are removed, the screws taken out and the Balsa wall allowed to swing down on to the floor.

This plan of removable Balsa sections can be applied to insulation either between frames or inboard of the framing. The additional space gained by inserting one of the layers of the Balsa wall section between the frames is an important factor in increasing the carrying capacity of the refrigerated space.

Balsa has also been used for a number of years in ships' ice boxes where its structure and insulating efficiency permits the construction of boxes to be placed anywhere, even exposed on deck. On ships where there is no refrigerating mechanism the saving in ice and the preservation of perishable food during long voyages are important factors favoring the use of Balsa.

FIRE PROTECTION OF INSULATED SPACES

In fire resisting qualities Balsa compares favorably with other insulating materials. Tests show an exceedingly slow flame penetration, due to the insulation action of the first surface charring. Balsa will not continue to glow or smolder, thereby greatly reducing the fire risk and eliminating those fires that have in the past been found almost impossible to extinguish where insulating materials have smoldered, with noxious gases, for days at a time. Another factor in the fire resistance of Balsa is the fireproof character of the waterproofing compound used on the Balsa panels, which contains a chemical well known as a constituent of fire extinguisher fillings. Lloyds and the American Bureau of Shipping have approved the use of Balsa for ships' insulation.

Further advantage that has been taken of the structure and high insulating value of Balsa is its use for the insulation of boiler and engine room casings and for the floors of crew quarters where, as on tankers, these are located over the boiler room. Where it is desired to install the Balsa panels on the inside of the casings, and for floor use, these panels are sheathed with sheet metal on one side which affords protection against wear and added resistance to fire. A number of such installations have already been made and others are in progress of construction. The additional comfort to passengers and crews resulting from the increasing use of Balsa for these purposes can be appreciated, especially by those who operate ships in the tropics.

Not only in ships but in many other phases of the transportation of perishable products, Balsa has begun to play a conspicuous part. Extensive test installations of this material as the insulation for refrigerator cars and automobile trucks show remarkable results in insulating efficiency and in the lessening of the weight of the carrier, with an increase in strength and permanence of structure.

Though refrigerator ships hitherto have been an unimportant factor in the American merchant marine, there are indications of an awakening interest in this type of tonnage. According to listings of April, 1921, the United States has only eighteen straight refrigerator ships, with a total of three and one-half million cubic feet capacity, consisting largely of refrigerator ships ordered by the government during the war. While this is entirely disproportionate to the greatly increased merchant tonnage of the United States, there are in addition to these vessels a number of ships engaged in the transportation of fruit, of which the outstanding example is the "great white fleet" of the United Fruit Company, whose refrigerated spaces aggregate about 5,000,000 cubic feet. Practically all of these fruit vessels were built in England.

As the material for the construction of containers for shipment of perishables by parcel post or express, Balsa, through its structural strength and woodworking facility, is opening up an entirely new transportation development. Ice cream, meat, fish, poultry and other products, chilled and packed in chilled Balsa containers, can be transported for great distances in excellent condition without further refrigeration. In addition to the lighter weight of the containers the elimination of the ice formerly required for packing materially decreases the shipping costs.

With the extension of these important and varied uses, Balsa may well lead to the development of adequate refrigerated cargo space and to the prevention of much of the waste now suffered in the transportation and marketing of perishable foodstuffs.

Another Burden for Shipowners Proposed

(*Concluded from page* 512)

in the old days. Thus, the Steamboat Inspection Service is now costing the country a little more than $1,000,000 a year and there would have to be determined the question of whether the old fees, graded on a sliding scale, would be restored, or a new fee basis adopted to raise that sum.

A question that also looms large, if this proposition is to be seriously taken up, is the treatment to be accorded vessels owned by the Government. The feeling of Secretary Hoover is that vessels engaged in the Government service should be inspected, licensed, etc., without payment of fees, but that this free service should not extend to the vessels owned by the Shipping Board Emergency Fleet Corporation. It is estimated that the bona-fide government vessels, such as the vessels of the Mississippi River Commission, the craft of the Quartermaster's Department of the War Department, etc., would not represent more than 5 percent of the total inspections.

Included in the Department of Commerce, and the object of especial solicitude on the part of the new Secretary, is the Bureau of Foreign and Domestic Commerce. It is via this institution that Secretary Hoover hopes to make investigations of port storage and harbor transfer conditions, etc., that should prove ultimately of distinct benefit to the shipping interests of the country as a whole. By this same instrumentality, also, Secretary Hoover plans an intensive study of the whole broad subject of "trade routes," a matter of the utmost importance at this juncture to shipping men no less than to shippers.

In connection with the Bureau of Foreign and Domestic Commerce it is gratifying to note that Congress has granted the additional appropriation that Secretary Hoover requested as necessary to efficiently carry on the work of this bureau. A large number of business men wrote personal letters to congressmen endorsing Mr. Hoover's request for this appropriation.

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One of the most interesting responsibilities that devolves upon the Commerce Department under the administration of Secretary Hoover consists of the distribution of medals of merit to the merchant marine in accordance with the provisions of the law with which our readers are doubtless familiar. The act of Congress provided for the conferring of the medals during the war period, with a period of three years allowed for the actual distribution. Congress has been asked for an appropriation of some thousands of dollars to provide the authorized medals.

In figuring on the medals likely to be required, the Commerce Department officials have based their estimates primarily on the fact that there are in the merchant marine some 35,000 officers and men who were on vessels which were torpedoed. With this as a working basis, the Federal officials, in conjunction with the best-informed members of the shipowners' association at New York, have applied the law of averages and analyzed prospective ability to quality until they have arrived at the deduction that about 500 medals will probably be required. The awards will be made by a board of three to five men of standing in the shipping world.

American Passenger Liner George Washington

(*Concluded from page* 507)

and one of which was occupied by the King and Queen of Belgium during their respective voyages upon this vessel. These suites are located on *B* deck at the foot of the monumental stairway from the grand social hall and each consists of a living room, dining room, bedroom and bath. These suites are marked with silver plates giving the names of their former distinguished tenants with brief reference to their voyages and will be a natural center of attraction to all travelers on board the vessel. The suite on the port side, used by President Wilson and the King and Queen of Belgium when on the vessel, is constructed in veneers of mahogany and rosewood, inlaid with satin and other lighter woods and decorated with panels of raised plastic. Mahogany and rosewood have been used freely in the furniture and every effort has been made to hold the room intact, as used by the President, for its deep historical interest.

A replica of the desk upon which the President prepared his first drafts of the Peace Treaty stands in the Presidential suite in the exact position occupied by the original, which has been presented to the President by the Directors of the Company. The beds, dressing table, toilet receptacles, portable furniture, etc., are in woods matching with the panel work of the room and exhibit some of the finest cabinet making that can be produced in the United States.

The foyers and open spaces of the *B* deck are decorated in a Continental style.

The interior of the rooms and suites forward of the main monumental stairway are finished in the choicest of hardwoods with the most elaborate and painstaking cabinet inlay work that can be obtained. The curtains, upholstery, hangings, etc., are of corresponding style and finish and the portable furniture in the rooms designed and manufactured for their specific locations. Baths and toilet rooms are fitted with the most modern and complete plumbing and finished generally in enamel tile.

The decks of each of the suites and rooms on *B* deck are heavily carpeted and laid with oriental rugs of the choicer weaves.

Electric Baths and Gymnasium

There are also upon *B* deck the electric baths with their adjacent massage rooms, showers and dressing rooms for the use of the passengers.

At the after end of the first class quarters on this deck is also found the gymnasium which is properly and simply furnished in maple and equipped with the usual athletic apparatus, ladies' and gentlemen's dressing rooms and bath rooms.

Lower Decks

The bed rooms and sitting rooms on the lower decks are constructed generally in a manner equal to that on the upper decks but with a less elaborate scheme of decoration and finish. The general character of these rooms throughout the vessel, however, is one of quality and refinement, wherein workmanship and materials have been used with utmost discrimination to produce appropriate results.

Main Dining Saloon

The main dining saloon, with a seating capacity of approximately 350, is located in the center of the vessel upon the lower first class passenger deck or *D* deck. The saloon is exceptionally commodious with ample clearance spaces in way of tables and surmounted by a center dome reaching to the second deck above.

The room is designed and constructed in the Colonial and Georgian style and finished in cool shades of French gray. The decorations of the dome consist of Doric and Ionian columns with a well designed wrought iron rail on the level of the upper deck which presents a most satisfying appearance of grace and lightness. Buffets and service tables are situated at convenient points and large mirrors fitted in the fore and after wall panels add to the spaciousness of the entire room.

The upholstery and hangings of the room are in old rose and all side lights are fitted with inner sashes and draped with silk curtains in corresponding shades.

The choicest of linen, silver, china and glass have been obtained and when the room is set an appearance of charm and refinement results which satisfies the most fastidious of tastes.

The Children's Dining and Play Room

The children's dining and play room, which is adjacent to the main dining room has been laid out as one of the most delightful spaces on board the vessel.

It is finished in French gray and old rose upholstery and decorated with gaily colored prints of suitable character to appeal to this highly prized group of passengers.

Second Class Accommodations

There are accommodations for 442 second class passengers in spacious state rooms with dining rooms, smoking rooms, sitting and writing rooms, etc., in a proportionate degree of elaborateness and with ample deck space for promenade and games.

The arrangement of these spaces is such that there can be no feeling of discrimination upon the part of the passengers traveling in these quarters.

Foyers and public rooms of the second class accommodations have also been carefully and appropriately worked out by the decorating architect and, while in more simple lines and details than the first-class, still exhibit the workmanship of a true artist and fully satisfy the most exacting.

Third Class Accommodations

Third class passengers to the number of 1,485 are accommodated in rooms containing two, four and six berths or in open compartments as the individual traveler may select. As in the case of the other classes, these accommodations are made up in part of dining rooms, smoking rooms, writing rooms, etc., so that the traveler in this class, while having less space and comparatively limited luxuries, may find himself in perfect comfort and cleanliness with unlimited light, air, heat and all the necessities of ocean travel.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in This Department

Conducted by James L. Bates

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Estimating the Painting of Ships

Q. (1125).—Can you inform me as to where I will find information relative to estimating for the painting of ships?

A. (1125).—It is assumed that your inquiry relates to the covering value of a given amount of paint, rather than to its cost, inasmuch as the cost would be dependent upon the conditions of the market, the character of paint, etc.

At once the most complete and most reliable information on this subject, with which the writer is familiar, is contained in the "General Instructions for Painting and Cementing Vessels of the United States Navy." A copy of this pamphlet may be obtained upon application to the Bureau of Construction and Repair, Navy Department, Washington, D. C.

In addition to regulations governing quality of material, mixture of ingredients, painting of surfaces, colors for different parts and types of ships, care and preservation of surfaces for varying conditions, use of cement, etc., this publication contains in tabular form, for some seventy-five different paint formulæ, the material, weight per gallon, spreading surface, ingredients, and quantities required for mixing various amounts.

In connection with the use of this information for purposes of estimating, attention is particularly invited to the following statement, which occurs in paragraph 63, page 37:

"The weights per gallon of paint and approximate area covered, as given in the following formulæ, are intended to be approximate only, these figures being dependent to a certain degree upon the materials used and the kind and condition of the surface to which the paint is applied."

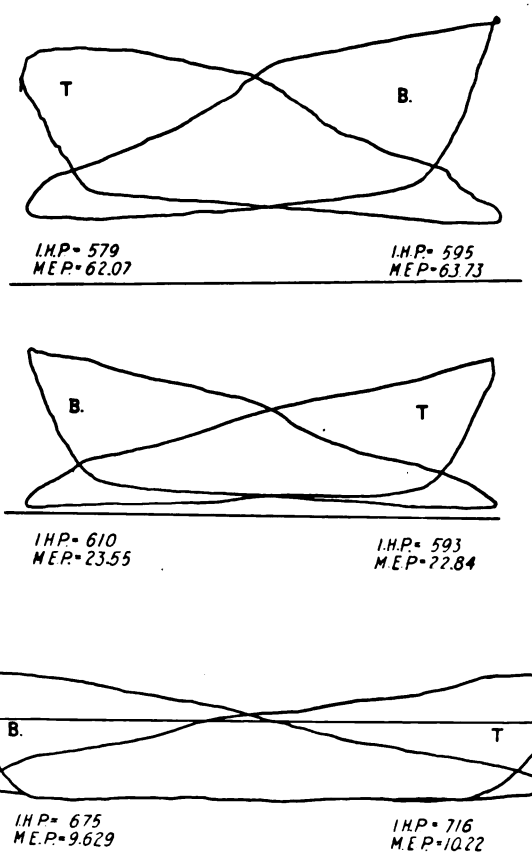
The values for spreading rate are generally based upon a metallic surface, but it will be readily appreciated that it is impossible to give a value which will be exact for even a metallic surface under all the various conditions which might obtain.

Engine Performance from Indicator Cards

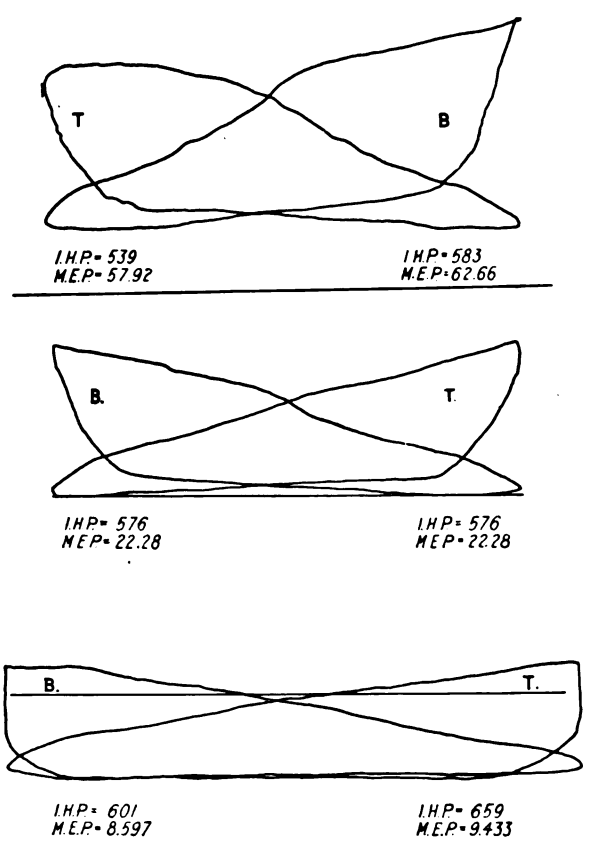
Q. (1121).—Please figure out and criticise the enclosed indicator cards. F. G. S.

A. (1121).—The loops at the top right side of the bottom high pressure cards indicate that the exhaust opening closes too soon, thus causing compression at the bottom end to begin too early, compressing up beyond the admission pressure, thus performing lost work.

The top left sides of the top high pressure cards show that



First Set of Indicator Cards



Second Set of Indicator Cards

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compression at the top end begins too late. When the piston starts its return stroke the pressure at once begins to drop; then admission takes place, causing the line to rise, a loop of negative work resulting.

To remedy this fault, move the valve along the valve stem in such a direction as to produce a later compression on the bottom end, which in turn will cause an earlier admission on the top end.

The intermediate and low pressure cards seem to indicate satisfactory setting.

The summary of mean effective pressures and indicated horsepowers follows:

MEAN EFFECTIVE PRESSURE

Set	H. P. Top	H. P. Bottom	I. P. Top	I. P. Bottom	L. P. Top	L. P. Bottom
First	62.07	63.73	22.84	23.55	10.22	9.629
Second	57.92	62.66	22.28	22.28	9.433	8.597

INDICATED HORSEPOWER

Set	H. P. Top	H. P. Bottom	I. P. Top	I. P. Bottom	L. P. Top	L. P. Bottom	Total
First	579	595	593	610	716	675	3,768
Second	539	583	576	576	659	601	3,534

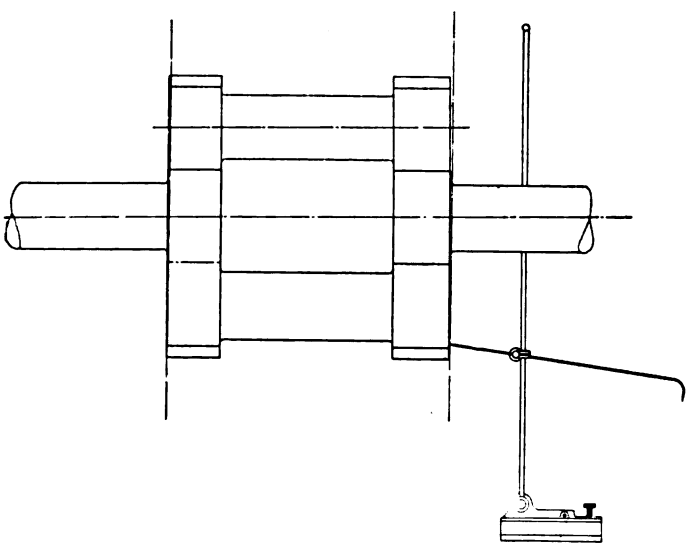
Diameter of piston rod not given and therefore neglected.

Lining Up Inclined Paddle Wheel Engines

Q. (1124).—On a vessel fitted with a pair of 17-inch by 72-inch paddle wheel engines resting on wooden framing foundations which have been running over 14 years there are indications that the cylinders have dropped down out of their original alinement. The main shafting, also a part of the crankshaft, is placed just beneath the main deck and thus becomes exceedingly unhandy to remove, as could be done conveniently in most screw vessels. Is there any method that could be used to test out or readjust their alinement without removing the crankshaft? A. H. C.

A. (1124).—Your question was taken up with two engineers of prominence and experience. Their suggestions are quoted below:

(a) Stretch two wires parallel with the shaft, one of the wires being in a horizontal plane containing the center of the



Sketch Showing Use of Surface Gage in Testing Alinement of Engine

shaft and the other wire being in a vertical plane containing the center of the shaft, then place the wires at a distance from the shaft so that it would be possible to get a straight passage for them. By measuring from the wire in the vertical plane to the shaft at various spots, the shaft can be made parallel to the wire and hence straight; by measuring to the wire in the horizontal plane, the shaft can be made parallel to that wire and hence straight in that plane. As these two planes are at right angles to each other or as near to right angles as circumstances will permit, the shaft which lies in both of the planes will be straight. The alinement of the cylinders, crossheads, guides, etc., presents no difficulties because the piston rods and connecting rods can be removed and the job lined in the usual way.

(b) Start by first placing the crank on the bottom center. By this I do not mean at the end of the stroke but on the quarter which would bring the crank at its lowest point with the piston half way of the cylinder. I would then find a definite point of contact either by surface gage, plumb line or straight edge and then turn the crank over to the exact opposite point or upper position. The difference as shown by the sketch would be the amount the engine was out of alinement. The line as shown in the sketch is the true position and the crank as shown is out of position.

(c) A quicker way would be to secure the crosshead and then center the wrist-pin brasses and secure them so that they cannot move. Then follow up to the crankpin and see that the crankpin brasses have an equal clearance on each side of the crank. Then turn this to the opposite position and see if the same results are obtained.

Either one of the two methods should be sufficient to give the information unless it is desired to strip the engine, taking out the pistons and running a line through the cylinder, through the center of the crosshead and up through to the crankpin.

Packing Pipe Joints

Q. (1127).—I would appreciate it if you would send any information, data or results of experiments on packing of the order shown in Figs. 1 and 2 for heavy and light pressures. I am especially interested in the material and best sections of light packing for gasoline, oil, etc.

A. (1127).—The best compilation of information relating to the above subject, with which the writer is familiar, is contained in "Instructions for Making Joints and Obtaining Watertightness and Oiltightness," General Specifications—Appendix 9—issued by the Navy Department, Bureau of Construction and Repair and Bureau of Engineering.

Certain large private shipbuilding yards make up joints for oiltightness in pipe lines either between flange and flange

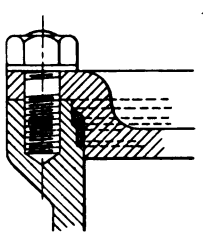


FIG. 1.

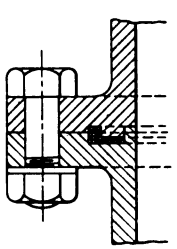


FIG. 2.

Original Section of Packing.

Original Section of Packing.

or between flange and structural members with trunk board gaskets. If the trunk board is dipped in water for a short time only (generally less than a minute) before it is placed in position, the joint makes up thoroughly tight and gives a good account of itself in service.

Joints of 8-inch pipe made up with this material as described above have been tested with oil under pressures of 26 pounds per square inch for 24-hour periods and found perfectly tight. A joint (flange to flange) in a 2-inch pipe line fitted with a trunk board gasket dipped in water about one minute before placing in position satisfactorily withstood an air test of 250 pounds per square inch.

Trunk board is made by mixing with sizing either raw paper pulp or refuse, such as sweepings, trimmings, etc., of paper products and compressing same into sheets under a very high pressure. Manila paper painted with shellac is also used in the joints of oil systems and this may be more convenient in certain cases.

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PERSONAL MENTION

REAR ADMIRAL W. S. BENSON, U. S. N. (retired), former chairman of the United States Shipping Board, has been appointed one of the Atlantic Coast representatives on the new Shipping Board. Born in Bibb county, Georgia, in 1855, Rear Admiral Benson was graduated from the Naval Academy in 1877. In 1879 he was promoted to the rank of midshipman and served on the U. S. S. *Constitution* for two years. In 1881 he was promoted to the rank of ensign, after which his promotions came in the following order: Lieutenant (Jr.), 1888; lieutenant commander, 1900; commander, 1905; captain, 1909; rear admiral, 1915; admiral (chief of naval operations), 1916. Admiral Benson has served as commanding officer of several of the first class dreadnoughts and at one time was chief of staff of the Pacific fleet. From 1907 to 1908 he served as commandant of midshipmen at the Naval Academy and was commandant of the Philadelphia Navy Yard and supervisor of the third, fourth and fifth naval districts from August, 1913, until April, 1915, when he was assigned to duty as chief of naval operations. In the latter part of 1917 he was assigned to temporary duty in London, after which he returned to the United States until he was ordered to special duty at Paris. He remained abroad until June 11, 1919. In the following year he was elected chairman of the Shipping Board for the unexpired term of John Barton Payne, who resigned to become Secretary of the Interior.

Rear-Admiral W. S. Benson

MEYER LISSNER, a Los Angeles, Cal., lawyer, has been appointed as one of the Pacific Coast representatives on the new Shipping Board. Mr. Lissner was born in San Francisco in 1871, received his education in the public schools at Oakland, Cal., and graduated in 1899 from the Los Angeles Law School. Since 1899 he has been engaged in the practice of law at Los Angeles. In 1907 Mr. Lissner organized the Los Angeles City Club and was its president in 1911. He was president of the Good Government Organization and chairman of the First Board of Public Utilities in Los Angeles in 1909. He was also active in organizing the reform movement in California in 1910 and was chairman of the State Central Committee in that year. Mr. Lissner has always maintained an active interest in California's public service and was a delegate to the National Committees in 1912 and 1920. From 1914 to 1918 he was editor of the *California Outlook* and from 1916 to 1920 a member of the California Industrial Accident Commission.

Meyer Lissner

THOMAS M. CORNBROOKS has been appointed assistant works manager of the New York Shipbuilding Corporation, Camden, N. J.

P. A. DEBUS, formerly connected with the Crescent Machine & Manufacturing Company, New Orleans, La., has been appointed general manager of the Jahncke Dry Dock & Repair Corporation, New Orleans, La.

FREDERICK I. THOMPSON, owner and publisher of the Mobile, Ala., *Register,* has been appointed to the Shipping Board as representative of the Gulf States. Mr. Thompson was a recess appointee to the Board under the Wilson administration, serving from December 1, 1920, to March 4, 1921; since that time he has remained in Washington as one of the trustees of the Emergency Fleet Corporation. Mr. Thompson has been in the newspaper and advertising business all of his life, starting with the Memphis *Commercial Appeal.* In 1900 he came to New York and for eight years was a member of the firm of Smith and Thompson, newspaper advertising representatives. He then went to Mobile and engaged in newspaper publishing where he became actively interested in the development of the Gulf ports, supporting the fight for the creation of the Alabama State Harbor Commission.

Frederick I. Thompson

EDWARD C. PLUMMER, an admiralty lawyer from Bath, Me., has been appointed to the Shipping Board as one of the representatives of the Atlantic Coast States. He was born in Freeport, Me., in 1863 and graduated from Bowdoin College in 1887. He began work as a reporter on the Bath *Daily Times* and in 1892 became proprietor and editor of the Bath *Independent.* In the course of his newspaper work Mr. Plummer became interested in shipping and when the Atlantic Carriers' Association was organized he became its first secretary and for 21 years has been active in its work. In recent years he has spent much time in Washington as the association's secretary and counsel and has appeared many times before Congressional committees investigating shipping matters.

E. C. Plummer

WILLIAM G. COXE, vice-president of the Pusey and Jones Company, Wilmington, Del., and Ernest Lee Jahncke, president of the Jahncke Dry Dock and Ship Repair Corporation, New Orleans, La., have been named to fill vacancies in the employers' representation on the Atlantic Coast Shipbuilding Industrial Board. The other shipyard representatives are M. A. Neeland, president of the New York Shipbuilding Corporation; John G. Pew, president of the Sun Shipbuilding Company, and Mr. Smith, vice-president of the

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Merchant Shipbuilding Corporation. The five labor representatives are James J. O'Connell, president of the Metal Trades Department of the American Federation of Labor; L. L. Letteer, International Association of Machinists; John Tobin, International Brotherhood of Blacksmiths, Drop Forgers and Helpers; Charles F. Scott, International Brotherhood of Boilermakers, Iron Shipbuilders and Helpers, and James A. Cooley, International Union of Steam and Operating Engineers.

GEORGE E. CHAMBERLAIN, former United States senator from Oregon, has been appointed a member of the Shipping Board representing the Pacific Coast States. Mr. Chamberlain was born at Natchez, Miss., in 1854. In 1870 he began work as a clerk in a general merchandise store in Natchez. From 1872 to 1876 he attended the Washington and Lee University and graduated in 1876. In December of that year he went to Oregon, where for a time he taught in a country school. Later he was appointed deputy clerk of his county and in 1879 resigned to practice law. In public life he has served as a member of the Oregon state legislature, as district attorney, attorney general of the state and for two terms beginning in 1903 as governor of Oregon. In 1909 he was elected to the United States Senate and in 1914 reelected.

Hon. G. E. Chamberlain

T. V. O'CONNOR, of Buffalo, N. Y., president of the International Longshoremen's Association, has been appointed to the new Shipping Board as representative of the Great Lakes States. Mr. O'Connor was born in Buffalo 52 years ago. In early life he was a tug worker in Buffalo harbor, later becoming a tug captain. Throughout his life he has been prominent in labor circles, first becoming identified with the Licensed Tugmen's Protective Association which was affiliated with the International Longshoremen's Association. Later he became a member of executive committee, vice-president and later president of that organization, which office he has held for 12 years. In 1921 he was appointed a member of the New York State Industrial Commission. Under the present administration he was offered the post of Assistant Secretary of Labor.

T. V. O'Connor

ELMER SCHLESSINGER, of the law firm of Mayer, Meyer, Austrian and Platt, of Chicago, has been appointed general counsel of the United States Shipping Board. E. M. Hyzer, who has been general counsel, will remain as an assistant to the general counsel. Mr. Schlessinger will receive a salary of $10,000 a year for his services in this post.

J. M. DAVIS, formerly vice-president of the Baltimore & Ohio, has been elected president of Manning, Maxwell & Moore, Inc., 119 West Fortieth street, New York City, to succeed the late A. J. Babcock. Mr. Davis was born on November 5, 1871, and began railway work in 1888. In 1916 he was appointed vice-president in charge of operation and maintenance of the Baltimore & Ohio System, with headquarters at Baltimore, Md., and held that position until July 1, 1918, when, under federal control of the railroads, he was appointed manager of the New York properties of the Baltimore & Ohio, including the Staten Island lines. In 1919 he left the Baltimore & Ohio to become president of the Rock Hill Iron & Coal Company and associated corporations, including the East Broad Top Railroad & Coal Company, with office at New York.

J. M. Davis

ROBERT W. MORRELL, naval architect of the Tidewater Oil Company, New York, has been appointed a member of the new technical committee of the American Steamship Owners' Association, of which William Francis Gibbs, naval architect of the International Mercantile Marine Company, is the chairman.

J. W. ISHERWOOD, of London, Eng., inventor and patentee of the Isherwood longitudinal system of ship construction, has been raised to the rank of Baronet. It is, therefore, as Sir Joseph W. Isherwood, Bart., that he is now being greeted by his many friends in this country where he has just arrived for a visit of several months. Sir Joseph was born at Hartlepool in 1870, and served his apprenticeship in the drawing office of Furness, Withy & Company, Limited, of West Hartlepool, remaining for some years in the service of this firm in various responsible positions. He was associated with Lloyd's Register of Shipping for eleven years, mainly in the capacity of surveyor on the chief ship surveyor's staff, and it was during this period that he became convinced that the then prevailing system of ship construction was not ideal from a scientific standpoint. He therefore set himself the task of evolving a system of construction that would provide increased longitudinal strength, and the result is seen in the longitudinal method of construction known as the Isherwood System which he patented in 1906. He severed his connection with Lloyd's Register in 1907, in order to devote his whole time to the "Isherwood" system, which was first introduced in the United Kingdom, the first vessel so constructed being the oil tank steamer *Paul Paix*, of 6,600 tons deadweight, and so phenomenal has the success of the system been that today there are about 1,400 vessels

Sir J. W. Isherwood, Bart.

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aggregating about twelve million tons deadweight carrying capacity, built, building and on order. Sir Joseph is a member of the Institution of Naval Architects, North-East Coast Institution of Engineers and Shipbuilders, the Society of Naval Architects and Marine Engineers (New York), Cleveland Institution of Engineers, and a Liveryman of the Worshipful Company of Shipwrights.

OBITUARY

E. L. ORDE, director of the Walker shipyard of Messrs. Sir W. G. Armstrong Whitworth & Company, Ltd., Newcastle-on-Tyne, Eng., died suddenly in London on May 28, at the age of 57 years. Mr. Orde was educated at Marlborough and the University College, London. He served his apprenticeship with Messrs. R. & W. Hawthorne Leslie & Company, Ltd., St. Peters, Newcastle-on-Tyne, to which firm he was ultimately appointed assistant general manager. Mr. Orde joined Messrs. Sir W. G. Armstrong Whitworth & Company, Ltd., in 1888, as assistant director of the Walker shipyard and on the death of the late Colonel H. F. Swan, was appointed director. Mr. Orde was president of the North East Coast Institution of Engineers and Shipbuilders from 1917 to 1919, and member of the Institution of Naval Architects, of the Institution of Mechanical Engineers, of the Institute of Marine Engineers and of the Engineers and Shipbuilders' Association of Scotland.

NEW BOOKS

SWEET'S ENGINEERING CATALOGUE, Seventh Annual Edition. Compiled, edited and published by Sweet's Catalogue Service, Inc., New York. Cloth, 1251 pages; size, 8½ by 11½ inches; illustrated and indexed.

Sweet's Engineering is a catalogue filing system which contains the separate catalogues of about seven hundred manufacturers. The field it covers is that of engineering and power plant equipment, or, to quote more definitely from the preface, it lists "Materials, equipment and supplies relating to the practical construction, equipment and maintenance of all projects of an industrial or engineering nature." In other words, the products it describes range from drawing boards to dynamos and from lighting receptacles to locomotive cranes.

The seventh edition of Sweet's Engineering Catalogue, which has just appeared, marks an improvement in many ways over those which preceded it. The products index, for example, has been revised and simplified, so that it is now much easier to locate any desired information. This information, in turn, has been arranged in a more logical fashion.

Coen Mechanical Oil Burning System to Be Installed on Government River Towboats

THE United States War Department has recently announced that all the vessels of the new fleet of Government towboats to be operated on the Mississippi and Warrior rivers are to be equipped with the Coen mechanical oil burning system. This system is now in successful operation on the *St. Louis* and *Cairo*, and is now being installed on the *Vicksburg*. The first vessel of this fleet, the *Natchez*, which was described on page 437 of our June issue, was originally equipped with the Leahy steam atomizing oil burning system, but in the near future the oil burners of this vessel will be changed from the steam atomizing to the mechanical type as in the other vessels.

LETTERS TO THE EDITOR

Derivation of Formulae in Paper on Double Reduction Gears for Merchant Ships

The paper on "Double Reduction Gears for Merchant Ships" by R. J. Walker, which was read at the annual meeting of the Institution of Naval Architects and reproduced in the May issue of MARINE ENGINEERING, does not give sufficient data for the application of the formulæ to the actual solution of a problem. In order to determine the units that are represented by the symbols used in this analysis, the writer went through the derivation of the formulæ and found the units.

On page 397 of the May issue the symbol a is used to denote flexibility of the shaft. This factor occurs several times on the sheet. This should be α to correspond with the coordinates of the curve in Fig. 3.

The units and symbols used are as follows:

f = frequency of the resistance moment of the wake.
n = number of blades of the propeller.
R = revolutions per minute of propeller.
p = frequency coefficient.
α = flexibility of shaft.
Is = polar moment of inertia of shaft section.
l = length of shafting in inches from gear to propeller.
G = shearing modulus of elasticity of shaft.
g = the acceleration of gravity.

The relations between the various units are given below:

$$f = \frac{n \times R}{60}$$

$$p = 2 \pi f$$

$$\alpha = \frac{1}{G\ Is}$$

Other units used in the calculations are defined in the paper.

DERIVATION OF FORMULA FOR FLEXIBILITY OF SHAFT

The fundamental formula for angular acceleration of a wheel or disk or propeller rotating about a polar axis is:

$$M = Ia \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where M = torque or moment in inch pounds.
I = moment of mass or polar moment of inertia of propeller.
a = angular acceleration in radians per second.

The fundamental formula for angular deflection of a shaft subjected to a twisting moment is:

$$M = \frac{\theta\ G\ Is}{l} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where M = same as above (torque).
θ = deflection of shaft in radians (twist).
G = coefficient of rigidity (about 12,000,000 for steel).
Is = polar moment of inertia of shaft section.
l = length of shaft in inches.

By algebra we get from (2)

$$\frac{\theta}{M} = \frac{l}{G\ Is} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

From Mr. Walker's paper

$$\alpha = \frac{\text{twist}}{\text{torque}} = \frac{\theta}{M}$$ by using above symbols for twist and torque.

Then from (3) we get $\alpha = \frac{l}{G\ Is}$

Newark, N. J. JAMES L. HAYNES.

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Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements —Engineering Projects—Improved Appliances

$4,800,000 Bond Issue Voted By City of Los Angeles, Cal., To Develop Harbor Facilities

Funds Included for Ferry and Terminals, Wharfage, Equipment and Dredging—$1,000,000 for New Pier—City Sees Bright Future Ahead for West Coast Shipping

LOS ANGELES, Cal. (Special)—Los Angeles citizens, fully awake to the importance of their harbor development as a distinct and definite profit-earning department of their city organization, voted June 7th with a large majority, an issue of $4,800,000 Harbor Bonds for port improvements.

The main channel from the Los Angeles outer to her inner harbor between the mainland and what is known as Terminal Island, while of ample depth, has long been criticized by shipping men using this port as being too narrow for the volume of business which is there developing. The main channel side of Terminal Island was occupied until recently by trackage of the Salt Lake Railroad. After negotiations extending over some time, the municipal officials arranged a deal with the Salt Lake Railroad by the terms of which the tracks of that road had been removed from the channel edge and a slice of Terminal Island along the channel bank, sufficient to give a minimum width of 1,000 feet to the main channel, is being cut off, dredged and the new water line of Terminal Island along the channel front, through the use of a portion of the issue of the bonds just voted, is to be made into the most modern type of wharfage with warehouses and cargo handling facilities.

Among other improvements to be immediately carried out with the bonds now rendered available, is the improvement of the West Basin. Around the shores of the West Basin is a very large acreage of partially "made" land. It is on seventy acres of this land completely reclaimed and with deep water all around it, that the plant and dry dock of the Los Angeles Shipbuilding & Dry Dock Company is located. The balance of the land as laid out in the plans of the city engineers, when reclamation work is complete and wharves built along its water edge, will provide accommodations for many large industrial plants needing rail and water shipping facilities. Of the bond issue just voted, $400,000 is to be set aside for this work.

Certain of the dredging operations in the formation of Inner Harbor channels and tide land reclamation is being done by the dredges of the Government; the exact amount of wharfage, cargo handling improvements, etc., which the city of Los Angeles will be able to accomplish with its $4,800,000 will be somewhat governed therefore by the degree of co-operation given by the Government in dredging operations.

The center of the city of Los Angeles is a little over twenty miles from the nearest waterfront at the harbor. From that waterfront point and on each side of it for several miles sweeping back towards the city are some thousands of acres of flat, easily dredged land—the most ideal of all for channels, wharves and industrial harbor front development progress. This great "apron" at the edge of the water supported by a modern city of over 600,000 population and fast growing, a few miles back is, in the opinion of its experts, one of the greatest of harbor assets. It is here that the modern harbor engineer can lay out the most suitable of industrial sites with water and rail transportation facilities, placing these where industry needs them.

The natural advantages of the outer harbor of Los Angeles with its broad sweep to the open sea and its ample protection for naval and merchant marine vessels inside its breakwater, have been noted by all who know the Pacific coast. Now that the city is developing a realization of what a great port will mean to it and is beginning to provide the means to build the docks, wharves, warehouses and cargo handling facilities demanded by shipping men, real and very rapid progress may be counted upon. Following is a list of the improvements planned to be carried out with the proceeds from the sale of the $4,800,000 of Harbor Bonds just authorized:

Municipal pier No. 1	$1,000,000
West Basin development	400,000
Fish Harbor improvements	500,000
Belt line railroad	300,000
Harbor boulevard	600,000
New sheds, etc., on east side of main channel	500,000
Ferry and terminals	200,000
Terminal Island seawalls	200,000
Wharves on west side of main channel	800,000
Equipment	300,000
Total	$4,800,000

$413,067,039 Agreed Upon by Senate and House for Navy Bill

The Naval appropriation bill carrying $413,067,039 has been agreed upon by the House and Senate conferees. This figure is an increase of $17,615,790 over the House bill.

The personnel of the Navy was fixed at 106,000 and the marine corps at 21,000.

Six Refrigerator Ships to Cost $1,500,000 Are Planned by Producers' Association

Investment of approximately $1,500,000 for the equipment of six ships with refrigerated space for the carrying of cargoes of fruit from the ports of Los Angeles and Seattle to Atlantic Coast points is contemplated in the plans of the Pacific Producers' Association, according to a statement by C. S. Whitcomb, its president. The carrying out of the plans will make possible a ten day service between the ports of Los Angeles and Seattle, each ship having 200,000 cubic feet of refrigerated space. It is considered likely that one or more ships will be equipped in three months and the full service of six ships established within six months.

World Machinery Market

A mammoth, comprehensive world market for machinery has been established in the building occupying the block of Sixth avenue, 18th and 19th streets, New York. It is a new style of world market, broad in scope thoughtfully planned and intended for American and international promotion of the sale of all American-manufactured mechanical products. It comprises exhibits of machinery of all kinds, and as New York is considered the biggest machinery center in the world, this new world market is looked upon as being of great advantage to manufacturers, selling agents and buyers. The Manufacturers' Exhibition Company, now permanently established, has located this concentrated market in the busy center, accessible to all surface, elevated and subway lines.

The machinery department contains all machine tools and iron-working machinery, pumps, valves and piping, lathes, planers, drilling machinery, horizontal and vertical boring machines, grinding machinery, automatic screw machines, drawing and punching boards, welding devices, heat treating equipment, and general machine tools, and various other mechanisms.

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New Construction Included in Coast, Bay and Port Developments

Numerous marine projects covering river and bay service, as well as port developments, are already under way or in contemplation, according to latest official reports.

The development of water transportation in the Chesapeake Bay and tributaries is being augmented through the establishment of service from Richmond to Norfolk by the Buxton Line and the rebuilding of several vessels for their account through Chapman & Fisher, Philadelphia, consulting engineers and naval architects.

Also, a program under way for coast and bay service calls for the construction of two small passenger and freight vessels for additional lines to be inaugurated early in 1922. Plans and specifications are being proceeded with by Chapman & Fisher and the vessels are to be constructed at their shipyard on the Great Lakes.

The vessels of the Diamond Steamship Company have been sold by the same engineering firm, and the company which was originally organized to develop service between North Atlantic ports and Ecuador, South America, will confine its attention to its machinery interests.

It is learned through official advices from John N. Cole, commissioner, Department of Public Works, Boston, that the Commonwealth of Massachusetts has let a contract for dredging and filling 1,000,000 cubic yards of material at East Boston, and the construction of about one-half mile of timber bulkhead, to retain a filling, to the Atlantic, Gulf & Pacific Company, Park Row Building, New York. The amount of the bid for this work, which is on the easterly side of East Boston, between Jeffries Point and Wood Island, is $351,400. It is also learned that the legislature has recently revised the harbor lines on the westerly side of East Boston in order to give better opportunity for the development of this area of flats.

Additions and extensions of the harbor facilities of Philadelphia are being actively promoted by the Department of Wharves, Docks and Ferries, of that city. It is now directly supervising the construction of six piers, and is strongly interested in promoting the port's interests in other directions.

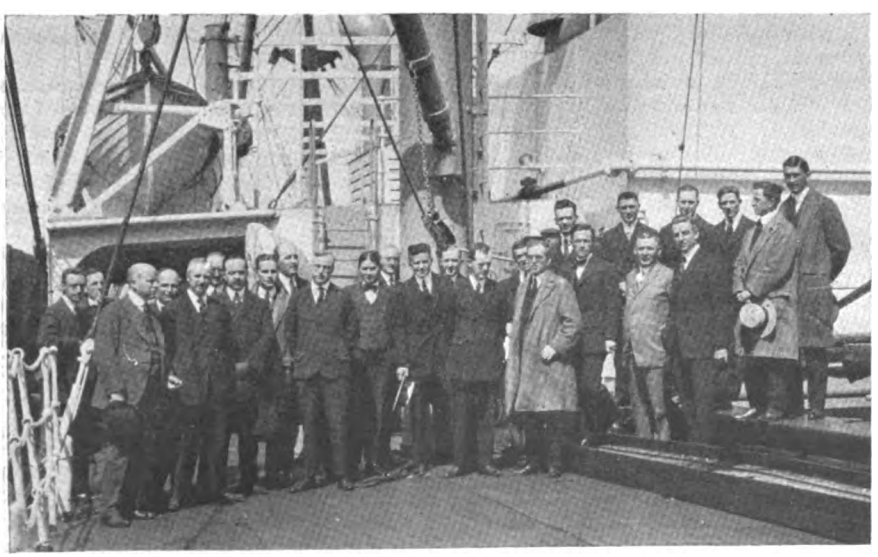
Marine Representatives Inspect the Electric Drive Ship "Eclipse"

Naval architects, consulting and superintending engineers of several steamship companies and representatives of various marine publications were guests of the General Electric Company on an inspection of the S. S. *Eclipse*, Tuesday afternoon, May 24.

Many inquiries have been received by the United States Shipping Board since the return of this first electrically propelled freighter, with a clean record for a trip of 26,500 miles, and it was in response to these that Commander V. V. Woodward suggested the inspection. The trip was under the direction of H. B. Taylor, chief turbine engineer of the Shipping Board.

The party, numbering about 35, made the trip to the ship, docked at Staten Island, in the Tebo yacht *Natalie Mae*. After inspecting the equipment and having it explained by General Electric engineers, the return was made to the Battery.

In the evening the engineers of the *Eclipse* were entertained at dinner by the General Electric Company at Corsican's, Brooklyn, in compliment to their services which tended to make this initial voyage the complete success it proved to be. Among the guests were H. B. Taylor; his assistant, George M. Walker, and P. J. Henning, electrical inspector of the Shipping Board.



Visiting Party on the Eclipse

TABLET PRESENTED

THIS TABLET DEDICATED
TO THE MEMORY OF THE MEN OF THE
AMERICAN MERCHANT MARINE
WHO GAVE THEIR LIVES IN THE WORLD WAR
THAT LIBERTY SHOULD PERPETUALLY ENDURE.
THESE MEN RENDERED ONE OF THE GREATEST
SERVICES THAT COULD HAVE BEEN DONE FOR OUR
NATION AND CIVILIZATION'S CAUSE. HUNDREDS
OF PRECIOUS LIVES WERE LOST — A LOSS THAT
CAN NEVER BE MADE UP BY THEIR COUNTRY.
WARREN G. HARDING.
PRESENTED TO THE NATION BY THE
WILLIAM H. McCLELLAND POST
N.Y. U.S.N.V. (U.S. SHIPPING BOARD DIVISION)
ON MAY 30, 1921.
DONATED BY WILLIAM H. TODD
TODD SHIPYARDS CORPORATION N.Y. CITY.

Appropriate ceremonies marked the unveiling at the Custom House, New York City, at 10 a. m., Memorial Day, of a bronze tablet dedicated to the memory of the men of the American Merchant Marine who lost their lives during the war. The tablet, which has been donated by William H. Todd, president of the Todd Shipyards Corporation, was presented to the nation by the William H. McClelland Post, U. S. Shipping Board Division.

INVINCIBLE'S TRIP

Electric Drive Ship Makes Foreign Voyage With Fine Results

The S. S. *Invincible*, of the Cosmopolitan lines, second of the electrically propelled cargo carriers, docked at Bayonne recently, having completed her first ocean voyage with new equipment, a trip to Rotterdam and return—7,300 miles—with highly successful results.

The *Invincible* left New York May 1 with a light cargo. Heavy seas were encountered, resulting in the propeller leaving the water on many occasions but there was no racing of the propeller. Her speed did not vary more than one revolution per minute, convincing proof of one of the important advantages of the electric drive. She started on her return from Rotterdam on May 21 with a cargo of 2,500 tons and again experienced rough seas but with the same results.

Her average speed for the trip 10.86 knots, which resulted in her making the voyage in more than one day's less time than similar boats not equipped with the electric drive. Officers on board were high in praise for the equipment, in fact Captain John Rehnberg, senior skipper of the Cosmopolitan lines and a man with 43 years sea experience, declared the electric drive the best means of ship propulsoin he has yet had anything to do with.

"You can't praise the electric drive too highly in expressing my first experience as commander of a vessel with the new type of propulsion," declared Captain Rehnberg. "It is absolutely the best means of propulsion I have encountered in my 43 years experience at sea."

The *Invincible* was built by the Bethlehem Shipbuilding Corporation at the Union plant, San Francisco, in 1918. She is the second of twelve 12,000 ton vessels being equipped by the General Electric Company with the electric drive for the United States Shipping Board.

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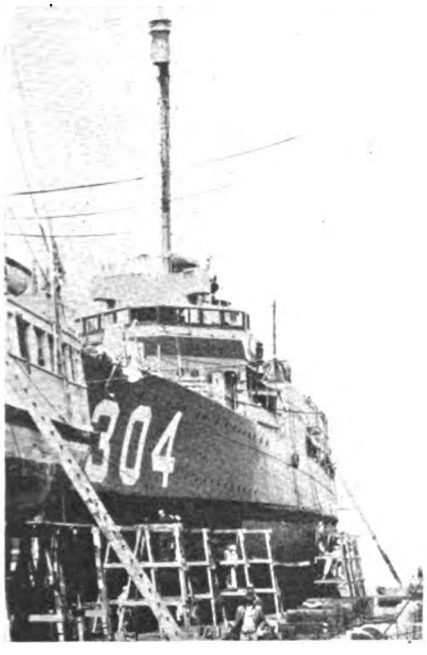
RECORD ESTABLISHED

West Coast Concern Does Exceptional Work on Destroyer

Lieutenant M. B. Pollock, naval constructor assigned to duty in the plant of the Los Angeles Shipbuilding & Dry Dock Company to supervise dry docking and repairs of United States destroyers and Pacific Fleet auxiliaries at that plant, is credited with the development of a particularly efficient system of handling each destroyer, with the result that through the cooperation of officials and personnel of the plant and of the commander, officers and crew of the ships to be docked, he has created a record of raising a destroyer, thoroughly cleaning the hull, painting it with two coats, cutting in the new waterline and undocking the ship, sending her on her way back to her base within the remarkably short space of five hours.



The destroyer *Farquhar,* commanded by Lieutenant R. G. Coman, entered the dry dock of the Los Angeles concern June 4, was officially raised at 10:35 A. M., and exactly at 3:33 P. M. the *Farquhar* was again afloat with the company's tug *Bedford* towing her clear of the dock and heading her seaward. These dry docking facilities permit of a destroyer leaving San Diego in the early morning, being raised, cleaned and painted with two coats, and returning, to be moored at her base again the same evening.

Baltimore Marine Show

The Baltimore Marine Show and Export and Import Exposition will be held in the 5th Regiment Armory, Baltimore, July 11-16, conducted by the Export and Import Board of Trade of that city. The show will be under the patronage of the Mayor of the city and civic officials, the Merchants & Manufacturers Association, the Board of Trade of Baltimore, the Baltimore Chamber of Commerce, and will be held under the auspices of the National Marine League.

Immigration Figures Show Aliens Arriving Since June 3 and the Number Permissible

Arrivals At American Ports Since Application of Restriction Law Already Exceed in Many Cases the Quota Allowed For the Entire Month

The arrival of immigrants who have come into American ports since the application of the restriction law of June 3, already exceeds, in the case of many nationalities, the quota allowed for these nationalities for the entire month, according to statements from Washington. Steamship men state that this condition is due entirely to the short time they were given in which to put the provisions of the law into effect and to what they term "unworkable methods" for carrying out the provisions of the law.

According to official figures, the United Kingdom, with 15,441, has the greatest limit per month for the fiscal year, 1921-1922.

The United States Department of Labor of the Bureau of Immigration has issued the following table, giving the number of aliens admissible under the act of May 19, 1921:

Country or Place of Birth.	Quota June 3-30 1921.	Quota Fiscal Year 1921-22.	Limit Per Month Fiscal Year 1921-22.
Albania	22	287	57
Austria	571	7,444	1,489
Belgium	119	1,557	311
Bulgaria	23	301	60
Czechoslovakia	1,095	14,269	2,854
Danzig	22	285	57
Denmark	433	5,644	1,129
Finland	298	3,890	778
Fiume	5	71	14
France	437	5,692	1,138
Germany	5,219	68,039	13,608
Greece	252	3,286	657
Hungary	432	5,635	1,127
Italy	3,224	42,021	8,404
Jugoslavia	491	6,405	1,281
Luxemburg	7	92	18
Netherlands	276	3,602	720
Norway	930	12,116	2,423
Poland	1,528	20,019	4,004
Eastern Galicia	451	5,781	1,156
Portugal (including Azores & Mad. Isl.)	177	2,269	454
Roumania	569	7,414	1,483
Russia (including Siberia)	2,627	34,247	6,849
Spain	51	663	133
Sweden	1,531	19,956	3,991
Switzerland	287	3,745	749
United Kingdom	5,923	77,206	15,441
Other Europe (including Andorra, Gibraltar, Malta, Lichtenstein, Monaco, San Marino and Iceland)	6	86	17
Armenia	122	1,588	318
Palestine	4	56	11
Smyrna District	34	438	88
Syria	69	905	181
Other Turkey (Europe and Asia)	16	215	43
Other Asia (including Persia and territory other than Siberia, which is not included in the Asiatic Barred Zone. Persons born in Siberia are included in the Russian quota.)	6	78	16
Africa	9	120	24
Australia	21	271	54
New Zealand	4	50	10
Atlantic Islands (other than Azores, Madeira and islands adjacent to the American continents)	5	60	12
Pacific Islands (other than New Zealand and islands adjacent to the American continents)	2	22	4
Total	27,298	355,825	71,163

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Marine Construction News of the Month

Ship Contracts — New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Repair Schooner, Boothbay, Maine.—The schooner Jennie Flood Kreger, which was in collision off Cape Henry recently, is being repaired at a cost of $40,000.

To Rebuild Vessel, Seaford, Del.—The schooner Arthur W. Robinson, purchased in a disabled condition at Miami by Captain John Quillen of Laurel, Del., will be rebuilt at the Vane Shipyard.

Hawkeye State Contract, Newport News, Va.—The contract for the alteration of the United States Shipping Board steamer Hawkeye State has been awarded to the Newport News Shipbuilding & Dry Dock Company on a bid of $97,550. The vessel is one of the 535-foot type.

Contract Awarded Shooters Island, New York.—The Standard Shipbuilding Company has been awarded the contract for repairs to the steamer Lord Ormonde, the company being the low bidder on the opening of tenders June 3.

Dump Scows, Wilmington, Del.—The American Car & Foundry Company has been awarded the contract for the construction of three wooden dump scows by the United States Engineer Department of New York.

Repair Contracts, Baltimore, Md.—The Globe Shipbuilding Company was awarded the contract for the repairs to the steamer Antinous, being the lowest bidder at $4,840.

Repair Contract Award, Baltimore, Md.—The Shipping Board has awarded a contract for docking and repairs to the steamer Sahala to the Baltimore Dry Docks & Shipbuilding Company, at a bid of $5,454. This company was the lowest bidder for repairs to the steamer Chickasaw at $570, and making changes on the submarine chaser allocated by the United States Navy to the Baltimore Fire Department, at a bid of $875. Contracts for repairs to the British steamers Pinar Del Rio at $1,409 and the Santa Clara for $1,399 were awarded to the Globe Shipbuilding Company, of Baltimore.

Shipyard Activities at San Francisco, Cal.—According to Gordon Glidden of the Moore Shipyards his company is now working on seven vessels. The boilers of the British tanker Tachee of the Standard Oil Company are being retubed and the craft is also undergoing a general overhauling at the yard. The tanker S. C. T. Dodd of the same company is being repaired, while five vessels are outfitting.

Ship Repair Bids, Hoboken, N. J.—The W. & A. Fletcher Company was low bidder for repairs to the Shipping Board steamer Old North State, tenders for which were opened at 45 Broadway, New York, on June 3. The price was $7,320. With a figure of $2,523, the Standard Shipbuilding Corporation, Shooters Island, were low bidders for the Shipping Board steamer Kamiset for repairs. The same company also bid low for the steamer Lord Ormonde, which was handled by McFarland & Garney, 32 Broadway. The price was given as about $24,000.

Reconditioning Contract, Hoboken, N. J.—The W. & A. Fletcher Company has been awarded the contract for reconditioning the Polish Relief ship Gdanst, which is being handled by Esplen Sons & McNaught, of 18 Broadway, New York. The work will include the renewal of the smokestack and uptakes, extensive bottom repairs, renewal of the tail shaft and various voyage repairs. It is understood that the contract will involve about $25,000.

Pilot Boat, New York.—The new boat for the Baltimore Pilots' Association will be completed on October 1 by Kyle & Purdy, Inc., New York, who have been awarded the contract. It was stated that the association has purchased the steel hull which was originally laid down by the Kyle & Purdy company for the French Government, and a compound engine, 18 by 38 by 26 inches stroke, will be installed. The vessel will also be equipped with one Scotch boiler, 13 feet 6 inches in diameter by 12 feet in length to carry 180 pounds of steam, working pressure. The boat is 150 feet long by 15 feet beam, having a depth of 14 feet 7 inches. The firm of Cox & Stevens, of New York, are the naval architects.

Refrigerator Ships, New York.—H. D. Donald, of 11 Broadway, New York, is acting as the representative of American interests who have under consideration the building of two refrigerator ships, according to official information obtained by MARINE ENGINEERING. It is understood that the proposed vessels are to be of from 2,000 to 2,500 deadweight tons, draft not to exceed 12 or 13 feet. It was announced that the vessels are to be equipped with triple expansion engines with oil burning equipment and are to have a speed of not less than 12 knots. If it is decided to build these ships, it was stated that they would be for delivery early next year.

Reconditioning Tanker, Hoboken, N. J.—The tank ship Pioneer, of the Standard Oil Company of New Jersey, was repaired by the W. & A. Fletcher Company, the latter concern having been awarded the contract, which included the reconditioning of the ship's fuel oil tanks, some new construction work, machinery repairs, together with repairing extensive bottom damage. It is believed the total contract involved over $20,000.

May Build Six and Purchase Two Vessels, New York—The Department of Street Cleaning submitted to the Board of Aldermen on June 7 a request that the Board authorize the purchase without public letting, of two (2) vessels known as "Eastman Dumpers," at a cost not to exceed $50,000, and of licenses to build six (6) vessels of a similar type under the patent rights held by F. P. Eastman at a sum not to exceed $75,000. Funds are available for these purposes out of appropriations made by the Board of Estimate and Apportionment on June 25, 1920, amounting to $625,000, and on March 19, 1921, amounting to $150,000, for the construction of five (5) sea dumpers and two (2) unloading plants. The purpose of these purchases is to add to the present fleet of vessels used for disposing of garbage at sea. The matter was referred to the Committee on Public Letting.

Torpedo Boats, Bridgeport, Conn.—The Lake Torpedo Boat Company may yet be awarded the contract for at least a number of the six submarine torpedo boats provided for in Senator McLean's amendment to the Naval Appropriation Bill, which authorizes the Navy Department to go ahead with the building of the six submarines specified in the 1916 naval program, according to latest reports from Connecticut. This optimistic view was given out following the return to Bridgeport of James F. Hennessey, who went to Washington in behalf of the employees of the Lake Company. It is understood that the six submarines will cost approximately $5,000,000 each, and that awarding of the contract to the Lake Company will mean employment for over 2,000 men.

Tanker, Wilmington, Del.—Announcement is made of the placing of a contract for the construction of a 2,500-ton tanker by the Atlantic Refining Company, of Philadelphia, with the Bethlehem Shipbuilding Corporation. The ship is to be 266 feet in length, 39 feet beam, and 20 feet deep. Construction will be on the Isherwood system of longitudinal framing, the work to be done at the shipbuilding company's Harlan plant.

Bids for Steamer Repairs, Halifax, N. S.—Bids for repairing the steamship Impoco which was rescued from Blonde Rock, off the Canadian Coast, and which was looked upon as one of the biggest repair contracts so far this year were opened at Halifax—the tenders showing prices ranging from $232,000 to $390,000. The Halifax Shipyards, Ltd., was low bidder at the figure of $232,000. Frazier-Brace & Company, of Montreal, was next with a figure of $260,000. The figures submitted by American shipbuilders and drydock companies ranged from $274,000 to $390,000, the firms from the states being handicapped to the extent of $39,500, which amount includes temporary repairs to make the vessel seaworthy for the trip to New York and tonnage charges in addition to the Canadian tax of 25 percent on repairs accomplished in the United States, together with the difference in exchange rate. It was agreed in order to offset this handicap that the time of commencement would begin when the vessel reached the successful bidder's yard and that no liquidated damages be assessed for failure to complete the work on time. The American bidders were the W. & A. Fletcher Company, Robins Dry Dock & Repair Company, New York Harbor Dry Dock Company, Staten Island Shipbuilding Company, Morse Dry Dock & Repair Company, the Baltimore Dry Docks & Shipbuilding Company. It was reported that the ship had been declared a total loss. If this should transpire, shipbuilders are interested in whether or not the vessel will be replaced. The bottom of the Impoco was virtually demolished and the repairs would necessitate extensive work on the propelling machinery and other equipment.

May Buy Ferryboats, New York—Purchase of the ferryboats, Florida, Joseph H. O'Donohue and Wyoming by the Department of Plant and Structures and their reconditioning for service under the jurisdiction of that department is expected soon, providing satisfactory terms can be agreed upon, according to announcement from Commissioner Grover A. Whalen. These boats will probably be started in service from East 23rd street to Greenpoint, Brooklyn, N. Y. Although the sum of $742,000 had been asked by Commissioner Whalen for the rebuilding of the ferry terminals at the foot of Broadway, Brooklyn, and at the foot of Grand street, Manhattan, and for the purchase or construction of ferryboats, it was stated that $696,000 of the original figure will be available.

Considering Ferry, Los Angeles, Cal.—It was learned from Mayor Snyder of Los Angeles through Edwin D. Vincent, harbor engineer, that the city is contemplating building a ferryboat to serve between San Pedro and East San Pedro. No plans have as yet been made and it may be some time before the matter will be actively taken up inasmuch as the channel is to be widened to 1,000 feet before this improvement can be undertaken. The city is at present completing the construction of a 200 horsepower tugboat for service in towing rock barges from the city quarry to Catalina Island to this port, also a 35-ton floating derrick barge for general use in the harbor.

Contracts Awarded, Hoboken, N. J.—The contract for voyage repairs and overhauling the lubricating oil system and the institution of new tanks in the ship Veedol of the Tidewater Oil Company has been awarded to the W. & A. Fletcher Company, to cost about $7,000. The same company has also been awarded the Shipping Board steamer West Point for general reconditioning at a similar figure.

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CONSTRUCTION FOR NAVY

Vessels under construction for the United States Navy and their degree of completion as reported May 31, 1921, by the Bureau of Construction and Repair, Washington, D. C., are as follows:

Type	Number and Name	Contractor	Per Cent. of Completion May 1 Total
		BATTLESHIPS (BB)	
44	California	Mare Island Navy Yard	97.
45	Colorado	New York S. B. Corpn.	73.1
46	Maryland	Newport News S. B. & D. D. Co.	99.2
47	Washington	New York S. B. Corpn.	65.
48	West Virginia	Newport News S. B. & D. D. Co.	54.1
49	South Dakota	New York Navy Yard	30.5
50	Indiana	New York Navy Yard	28.
51	Montana	Mare Island Navy Yard	24.4
52	North Carolina	Norfolk Navy Yard	32.3
53	Iowa	Newport News S. B. & D. D. Co.	23.
54	Massachusetts	Beth. S. B. Corpn. (Fore River)	6.4
		BATTLE CRUISERS (CC)	
1	Lexington	Beth. S. B. Corpn. (Fore River)	18.7
2	Constellation	Newport News S. B. & D. D. Co.	10.5
3	Saratoga	New York S. B. Corpn.	22.4
4	Ranger	Newport News S. B. & D. D. Co.	1.8
5	Constitution	Philadelphia Navy Yard	7.7
6	United States	Philadelphia Navy Yard	7.7
		SCOUT CRUISERS (LIGHT CRUISERS CL)	
4	Omaha	Todd D. D. & Const. Corpn.	92.1
5	Milwaukee	Todd D. D. & Const. Corpn.	89.2
*6	Cincinnati	Todd D. D. & Const. Corpn.	81.7
7	Raleigh	Beth S. B. Corpn. (Fore River)	56.7
8	Detroit	Beth S. B. Corpn. (Fore River)	56.6
9	Richmond	Wm. Cramp & Sons Co.	66.
10	Concord	Wm. Cramp & Sons Co.	63.
11	Trenton	Wm. Cramp & Sons Co.	45.
12	Marblehead	Wm. Cramp & Sons Co.	43.
13	Memphis	Wm. Cramp & Sons Co.	37.

*Scout cruiser (light cruiser) No. 6—Launched 5-23-21.

		AUXILIARIES	
Fuel Ship No. 18, Pecos (Oiler AO6)		Boston Navy Yard	88.
Repair Ship No. 1, Medusa (AR1)		Puget Sound Navy Yard	62.4
*Dest. Tender No. 3, Dobbin (AD3)		Philadelphia Navy Yord	62.3
Dest. Tender No. 4, Whitney (AD4)		Boston Navy Yard	25.
Sub. Tender No. 3, Holland (AS3)		Puget Sound Navy Yard	17.8
Aircraft Tender, Wright (AZ1)		Tietjen & Lang	76.

*Destroyer Tender No. 3—Launched 5-5-21.

		PATROL VESSELS	
Gunboat No. 22, Tulsa (PG22)		Charleston Navy Yard	67.7

Authorized but not under construction or contract.
(1) Transport No. 2.

		DESTROYERS	
332	Farenholt	Beth. S. B. Corpn. (San Fran.)	Del.
333	Sumner	Beth. S. B. Corpn. (San Fran.)	Del.
334	Corry	Beth. S. B. Corpn. (San Fran.)	Del.
335	Melvin	Beth. S. B. Corpn. (San Fran.)	Del.
338	Wasmuth	Mare Island Navy Yard	97.7
339	Trever	Mare Island Navy Yard	94.8
340	Perry	Mare Island Navy Yard	61.4
341	Decatur	Mare Island Navy Yard	57 6

Destroyers authorized but not under construction or contract.
(12) Nos. 348 to 359 inclusive.

		SUBMARINES	
115	S-10	Portsmouth, N. H., Navy Yard	90.8
116	S-11	Portsmouth, N. H., Navy Yard	86.8
117	S-12	Portsmouth, N. H., Navy Yard	78.1
118	S-13	Portsmouth, N. H., Navy Yard	75.
123	S-18	Electric Boat Co. (Quincy)	97.
124	S-19	Electric Boat Co. (Quincy)	96.5
125	S-20	Electric Boat Co. (Quincy)	98.5
126	S-21	Electric Boat Co. (Quincy)	94.9
127	S-22	Electric Boat Co. (Quincy)	95.8
128	S-23	Electric Boat Co. (Quincy)	94.
129	S-24	Electric Boat Co. (Quincy)	93.
130	S-25	Electric Boat Co. (Quincy)	93.5
131	S-26	Electric Boat Co. (Quincy)	92.4
132	S-27	Electric Boat Co. (Quincy)	91.
133	S-28	Electric Boat Co. (Quincy)	91.6
134	S-29	Electric Boat Co. (Quincy)	90.5
136	S-31	Electric Boat Co. (San Fran.)	97.5
137	S-32	Electric Boat Co. (San Fran.)	95.6
138	S-33	Electric Boat Co. (San Fran.)	99.2
139	S-34	Electric Boat Co. (San Fran.)	94.8
140	S-35	Electric Boat Co. (San Fran.)	90.7
141	S-36	Electric Boat Co. (San Fran.)	86.6
142	S-37	Electric Boat Co. (San Fran.)	82.8
143	S-38	Electric Boat Co. (San Fran.)	72.6
144	S-39	Electric Boat Co. (San Fran.)	71.6
145	S-40	Electric Boat Co. (San Fran.)	71.9
146	S-41	Electric Boat Co. (San Fran.)	73.6
153	S-42	Electric Boat Co. (Quincy)	64.6
154	S-43	Electric Boat Co. (Quincy)	64.8
155	S-44	Electric Boat Co. (Quincy)	63.1
156	S-45	Electric Boat Co. (Quincy)	63.9
157	S-46	Electric Boat Co. (Quincy)	62.2
158	S-47	Electric Boat Co. (Quincy)	61.8
159	S-48	Lake T. B. Co. (Bridgeport)	91.4
160	S-49	Lake T. B. Co. (Bridgeport)	85.2
161	S-50	Lake T. B. Co. (Bridgeport)	81.7
162	S-51	Lake T. B. Co. (Bridgeport)	71.2

		FLEET SUBMARINES	
60	T-2 (SF 2)	Electric Boat Co. (Quincy)	98.7
163	V-1 (SF 4)	Portsmouth, N. H., Navy Yard	2.8
164	V-2 (SF 5)	Portsmouth, N. H., Navy Yard	2.8
165	V-3 (SF 6)	Portsmouth, N. H., Navy Yard	2.8

Fleet Submarines (6) Nos. 166 to 171.
Neff Submarine (1) No. 108.
Note: Submarines authorized but not under construction or contract.

Repairing Steamers, Baltimore, Md.—The Baltimore Dry Docks & Shipbuilding Company was the lowest bidder at a figure of $1,712, on the contract for the removal and installation of a new turbine engine in the Shipping Board steamer West Raritan. The H. E. Crook Company, also of Baltimore, was awarded the contract for repairs to the Lake Ellerslie at a bid of $532. A contract to repair the lighthouse tender Orchid has been awarded by the Bureau of Lighthouses to the Spedden Shipbuilding Company, of Baltimore, Md.

New Passenger Vessel, San Francisco, Cal.—Lebeus Curtis, of the firm of Pillsbury & Curtis, marine surveyors, has arrived at San Francisco from Honolulu where he had been for the past month studying shipping conditions and advising with the managers of the Interisland Steam Navigation Company in regard to a new steamer they contemplate building. Plans for going ahead with the vessel are being held in abeyance, but it is understood that when she is built the contract will go to a San Francisco shipyard. The vessel is to be a little larger and a little faster than any the company now has plying between the various islands, the largest of which is about 1,600 gross tons. She will have accommodations for 200 passengers and will make about 16 knots.

Derrick Boats—The United States District Engineers Department, Custom House, Nashville, Tenn., let a contract for the construction of two derrick boats to the Howard Ship and Dock Yards, Division and Market streets, Jeffersonville, Ind., at a price of $11,490 each.

To Install Engines—Consideration is being given a plan to install engines in several former German barks now lying off Sausalito, fostered by W. L. Comyn, and to this end draftsmen of the Union Iron Works, San Francisco, Cal., have submitted specifications for installing 500-horsepower engines in the bark Hans. In the event of a decision to carry out the project, engines now in motorships of the Pacific Freighters Company will be used, according to Mr. Comyn. These engines have a speed of 10 knots and are capable of generating 600 horsepower.

Ship in Collision—The Shipping Board steamer Charlot, which recently encountered an iceberg, is now in the harbor of St. Johns, N. F., with her entire forepart wrecked, her first bulkhead being shattered. Repairs will require three months' work, it is estimated.

Tugboats Building—The Transportation & Shipping Company, Ltd., Sorel, Can., are busy completing two ocean-going steel tugs, 133 feet long and of 600 horsepower. Two wooden tow barges of 1,800 tons each are also being constructed by the same company for their own account.

SHIPYARDS AND DRY DOCKS

Dry Dock, Baltimore, Md.—The Union Shipbuilding Company has engaged the Crandall Engineering Company, Boston, Mass., to install a standard Crandall railway dry dock of 4,000 tons lifting capacity. This new dock will measure 360 feet over the keel blocks, 70 feet wide, with 15 feet of water forward and 20 feet aft over the blocks, and will be capable of docking vessels up to and including the 8,800-ton class of ships. A large quantity of material is now on the ground and the construction will be started as soon as dredging is completed.

Dry Dock, Sydney, N. S.—The railway drydock being built for the Sydney Foundry and Machine Works, Ltd., is designed and is being constructed by the Crandall Engineering Company of Boston, Mass. Vessels displacing up to 1,200 tons will be accommodated on this new dock, which measures 200 feet over the keel blocks, 50 feet wide and gives 10 feet of water forward and 16 feet aft over the blocks. The construction will be complete and the dock in operation in about two months.

Drydock, Etc., Miami, Fla.—The Merrill Stevens Drydock & Repair Company, Jacksonville, Fla., is reported to be contemplating the establishment of a marine repair plant at Miami, Fla.

To Sell Shipyard, New Orleans, La.—The French High Commission, New York, is offering for sale the Foundation Company's yard at New Orleans, where the 6,000 ton La Parmentier type ships were built. The yard covers an area of 90 acres with a launching basin of 20 acres. The yard has three launching ways.

Drydock, New Brunswick, Can.—The St. John Dry Dock & Shipbuilding Company will build and operate a first class drydock for naval and general purposes. The drydock will be capable of taking ships over 600 feet long and will embody in its construction the last and most efficient features, and be equipped with a traveling crane capable of lifting 40 tons at a reach of half the width of the dock, which is to be 1,150 feet in length. Preparations are being made to proceed with the concrete construction of the dock this summer. A. R. Dufresne is engineer and manager.

PORT IMPROVEMENTS

Pier Equipment, New York City—Resolutions recommending to the Board of Estimate and Apportionment that the comptroller be authorized to issue corporate stock to the amount of not exceeding $430,000, the proceeds whereof to be used for equipment of piers now in the course of construction at Staten Island, were unanimously adopted at the recent meeting of the Commissioners of the Sinking Fund. The equipment includes seventy-two 2-ton cargo winches with wiring at $3,000 each, a number of capstans, cargo chutes, cargo booms, and railroad tracks and crossovers.

Cranes for South America—The Industrial Equipment Company, 149 Broadway, New York, is reported to be receiving bids on a South American inquiry calling for forty 1-ton 10 to 12 foot boom, gasoline operated, solid rubber tired truck cranes for operation on docks.

Piers, Equipment, Etc., Norfolk, Va.—The Port Commission has plans and final estimates of proposed harbor improvements including grain elevator, additional piers and warehouses, and equipment. Neff & Thompson, Seaboard Bank Building, Norfolk, and Folwell, Ahlstog & Company, McCormick Building, Chicago, Ill., are the architects.

Million Dollar Pier, Venice, Cal.—The Sunset Pier Company, Trollyway, let a contract for the construction of an amusement pier 700 feet into the ocean, 607 feet frontage, and 100 feet wide, to be horseshoe shaped, of concrete or willite surfaced deck on wood piles, to Murdock & Condel, 1715 West 24th street, Los Angeles, Cal. The entire project will cost about $1,000,000.

Dredging, Minnesota—C. E. Boughton, attorney for the State Drainage Board at Red Lake Falls, Minn., will receive bids until July 15 for dredging and straightening the Clearwater River, involving the expenditure of about $100,000. G. Walker, Thief River Falls, is engineer.

Wharf, Valparaiso, Fla.—John P. Perrine, mayor, has let contract for the construction of a 48 by 72 foot wharf and loading docks, etc., to the Holbrook, Rowland Construction Company, at a cost of $6,000. N. C. Rowland is engineer.

Dredging, Goderich, Ont.—The Department of Public Works, Parliament Building, Ottawa, Can., is receiving bids for dredging the harbor, involving 50,000 cubic yards floating dredgework, at an estimated cost of $30,000. E. LaFleur, Parliament Building, is engineer.

Breakwater, Twillingate, Can.—The sum of $25,000 has been secured for the construction of a breakwater at Twillingate, New Foundland harbor, and work is to be started soon. The Government has sent engineers to look over the site and to report whether it is the best possible in the interes of the people of Twillingate.

May Build Piers, New York—Matters which were referred to the Committee of the Whole by the Sinking Fund Commission of the City of New York, at its meeting on May 28, 1921, include requests from the Commissioner of Docks for adoption of a resolution recommending to the Board of Estimate and Apportionment that the comptroller be authorized to issue corporate stock in the sum of $540,000 to cover the cost of removing the present pier at the foot of West 44th street, Manhattan, and constructing a new pier in its place; also an issue in

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the amount of $100,000 for the construction of a bulkhead wall and for removing portions of the piers, sheds and cribs on the inshore ends of piers (old) 1 and 2, North River.

Dock, Hollister, Mo.—The city will construct a dock at the mouth of Turkey Creek at Lake Taney. Address the mayor.

Terminal, Demopolis, Ala.—The city contemplates the construction of a river terminal to cost $50,000.

Ferry, Valparaiso, Fla.—John B. Perrine, mayor, invites bids on the construction of a ferry across Valparaiso Bay.

Wharf, Etc., Valparaiso, Fla.—Bids will be received by John B. Perrine, mayor, for the construction of a wharf and warehouse on Sunset Bay.

Terminals, Helena, Ark.—The city plans the construction of wharf, boat and railway facilities along the waterfront. Address the mayor.

Pier, New Bedford, Mass.—W. S. Rendle, 135 Prescott street, East Boston, Mass., has been awarded a contract for the construction of a pier at the New Bedford and Fairhaven drawbridge, at a cost of $48,413.

Wharf, Marion, Mass.—The town plans to build a concrete wharf on Sippican Harbor to cost about $25,000. The engineer has not as yet been selected.

Dock, Bulkhead, Palmetto, Fla.—W. E. Mann, clerk for the city, has let a contract to George Skene for the construction of a municipal dock and bulkhead to cost $20,000.

Dredging and Equipment, Miami, Fla.—The city will soon vote on $50,000 for the purchase of a bucket dredge, barge, gas towboat, etc. C. W. Murray is engineer.

Terminal, Charleston, S. C.—John P. Grace, mayor of the city, is interested in acquiring waterfront property for the purpose of constructing a terminal to be equipped with the most modern appliances, cranes, etc.

Bulkhead, Wharves, Etc., Covington, La.—The Fourth Ward of St. Tammany Parish will construct bulkheads and wharves and dredge harbor at Bayou Castaign, for which they have $25,000 bonds.

To Dredge Channel, Clearwater, Fla.—The Sunset Point Company has been organized with J. B. Discus, president, Chicago, Ill.; J. B. Paine, secretary and treasurer, Clearwater. The company will dredge the channel and basin from the main channel of Clearwater Harbor to the railroad.

Dock, Duluth, Minn.—The Inland Coal & Dock Company, 59th avenue, W., has awarded a contract for a 500-foot extension to their dock to R. C. Buck, Inc., United States National Bank Building, Superior, Wis. The estimated cost of the work is about $200,000.

Breakwater, Port Colbourne, Can.—The Department of Public Works, Paret Building, Ottawa, Can., let contract for repairing the breakwater to the Port Arthur Construction Company, Ltd., Excelsior Life Building, Toronto, involving an expenditure of about $55,000.

Produce Pier, Philadelphia, Pa.—Director Sproule of the Department of Wharves, Docks and Ferries, has suggested the construction of a produce pier, 80 feet wide and extending more than 150 feet into the river. At present no such pier is available within the central section of the river front.

Coal Terminal, Blakely Island, Ala.—Hampton Reynolds, of New Orleans, La., has received official notice that his bid of $100,000 for the construction of the Government coal terminal at Blakely Island has been accepted, construction of which must be completed in 150 days. Contracts for machinery to be installed are expected to be placed soon.

Drydock, Valparaiso, Chile—It is reported that contracts have been let by the Chilean Government for the construction of a drydock of 2,500 tons capacity. Concessions covering the new drydock extend over a period of thirty years, at the end of which time the Government shall have the right to purchase the dock and equipment.

Terminals, Nashville, Tenn.—A. J. Dyer, chairman of the Board of Transportation, let a contract to Foster & Creighton to construct concrete river and rail terminals, including a warehouse. The project involves the expenditure of $300,000. Freeland Roberts, Independent Life Building, is engineer.

Municipal Piers, Baltimore, Md.—The Port Development Commission purchased for $212,500 a tract adjoining the city's McComas street development, the site having 429 feet of water frontage, 1,400 feet deep, and contemplates the construction of groups of municipal piers. H. G. Perring is chief engineer, and Bancroft Hill harbor engineer.

Pier, Portland, Me.—According to Henry G. Merrill, chairman of the Port Directors of Maine, actual construction will soon start on the new 1,000-foot pier to be built at Portland, and for which the State has appropriated $1,500,000. The pier will be 1,000 feet long and 360 feet wide, with 35 feet of water alongside. The most modern freight-handling equipment will be installed. It is expected that the pier will be completed in a year.

To Improve Barge Canal, New York—According to a statement accredited to State Superintendent of Public Works Cadle, whatever can be done to improve the New York State Barge Canal facilities will be undertaken. The work of dredging the canal will be carried on vigorously with a view to maintaining a depth of 12 feet and arrangements have been made to lease extra equipment to facilitate the work. Electric cranes will be installed at all State owned terminals along the canal until the line is equipped. Steps will be taken to secure better coal handling facilities, thus eliminating the delays under the present methods.

Pier, Etc., Hayward's Creek, Mass.—Plans have been made for the construction of a pier for general business uses. At this point the Bethlehem Shipbuilding Corporation and the Massachusetts Oil Refining Company have recently made extensive improvements. On the opposite side of the river in Weymouth the Edison Electric Illuminating Company is understood to be planning extensive developments which have not as yet reached the contract period. The United States Government has just completed the dredging of the Malden River, and the Locke Coal Company and the Champlin-Hobbs Box Company are constructing wharves alongside the new channel.

Steel Contract Awarded, Chester, Pa.—A contract to furnish structural steel for a large grain elevator being erected by the New York Barge Canal Company at Gowanus Bay, Brooklyn, has been awarded the Merchant Shipbuilding Corporation, Chester, Pa., by the Segles Construction Company of Minneapolis, Minn. Awarding of the contract follows the announcement recently of the Merchant Shipbuilding Corporation that it was expanding its facilities to enter the structural and general engineering fields. The recent increase of contracts of this nature is believed to indicate a revival of activity in steel construction.

GOVERNMENT WORK

Machinery Installation, Oakland, Cal.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., having nearly completed the erection of a new ship fitters' shop at the Mare Island Navy Yard, will soon commence the installation of machinery in the various shops, including an angle shop, plate shop and forge and blacksmithing shops. A mold loft will be located over one of the bays.

Tanks, Chelsea, Mass.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for installing two new gasoline storage tanks and one new pump at the Naval Hospital.

Centrifugal Pumps, Etc., Point Isabel, Tex.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for furnishing and installing a motor-driven centrifugal pump and constructing a pump house.

Dredging—The United States Department of Engineers, J. Cyrille Dupont, will dredge 1½ miles connecting Bayou Black and Bayou Terrebonne, link of intercoastal canal from Houston to New Orleans.

Terminal Equipment, Birmingham, Ala.—The War Department, H. T. Bardeleven, manager of the Warrior River Section, Inland and Coastwise Service, 714 Brown Marx Building, let a contract to the American Hoist & Derrick Company, St. Paul, Minn., for the erection of an additional derrick in order to double the loading and unloading capacity of the port.

Dredging, New York—The United States Engineer Office, Room 710, Army Building, 39 Whitehall street, let a contract for dredging in Newtown Creek to the Columbia Dredging Corporation, 30 Church street, New York.

Breakwater, Indiana Harbor, Ind.—The United States Engineer Office, Milwaukee, Wis., has completed plans for the construction of the superstructure of the breakwater at Indiana Harbor, Ind., the foundation of which has already been laid. The sum of $4,000,000 will be expended for the completion of this project.

Breakwater—The Treasury Department, Washington, D. C., will receive bids until July 5, 1921, for the construction of a breakwater and placing riprap at Galveston, Texas. J. A. Wetmore is acting supervising architect.

Fire Alarm System—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until July 6 for constructing additions to the fire alarm systems at Puget Sound, Washington.

Fire Alarm System—Specification 4470, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to construct a fire alarm and watchman's signal system at New York City, N. Y.

Electric Traveling Platforms and Hoists.—Specification 1356, the Bureau of Yards and Docks, Navy Department, Washington, D. C., let a contract for constructing electric traveling platforms and hoists at the Naval Air Station, Lakehurst, N. J., to the Milwaukee Electric Crane & Manufacturing Company, Ind., Milwaukee, Wis., the work to be completed in 150 days at a cost of $34,000.

NEW INCORPORATIONS

The Inland Contracting & Wrecking Company, Wilmington, Del., has been incorporated, with a capital of $10,000, to reclaim sunken vessels, by John P. Cann, Henry McKeown and W. N. Tyson.

The Parkersburg Dry Docks, Transportation & Coal Company, Moundsville, W. Va., has been incorporated, with a capital of $250,000, by M. J. McQuade, J. R. Dorsey and others.

The Tri-State River Navigation Company, Columbus, Ga., has been incorporated, with a capital of $100,000.

The Whitaker Marine Construction Company, San Francisco, Cal., has been incorporated, with a capital of $25,000, by J. S. Whitaker, P. H. Whitaker, H. C. Mitchell, R. W. Gray, H. C. Wilson and L. F. Baker.

The Cranes' Shipyards, Ltd., North Vancouver, B. C., have been incorporated with a capital of $10,000 to carry on a business of shipbuilders, ship repairers, drydock owners, and operators and to own and operate ships of all kinds.

The Ocean Motorship Company, San Francisco, Cal., has been incorporated by W. E. Gerber, Jr., Ralph Roberg and C. N. Howard, all three affiliated with the Comyn interests. Arrangements have been made for the company to purchase the claim of the Australian Government for $1,625,000 against the Pacific Motorship Company for $125,000, thus eliminating the Commonwealth entirely from any interest in the eight wooden motorships and reducing their cost from $2,400,000 to $905,000.

Eastern Stevedores, Ltd., Montreal, Can., has been incorporated with an authorized capital of $50,000 to carry on a business as stevedore, shipowner, shipwright, wharfinger, etc., and general transportation, as well as to own and operate other ships of every description. The incorporators include J. McNaughton, J. G. Cartwright, J. V. Taylor, A. McIntyre and T. J. Griffin, all of Montreal.

The Midland Barge Company, East Liverpool, Ohio, has been incorporated with a capital of $100,000.

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The Aliquippa Navigation Corporation, Dover, Del., has been incorporated with a capital of $100,000 for a freight and passenger transportation business by vessels.

The Anahuac Steamship Company, Inc., Manhattan, New York, has been organized with a capital of $100,000 to carry on a navigation business. R. L. Coffey, 59 Pearl street, New York City, is the incorporator.

The Bulk Fruit Steamship Corporation, 841 Calvert street, Baltimore, Md., has been incorporated by W. Ainsworth Parker, John G. Schilpp and John B. Diggs to carry on a steamship business.

The Houston Marine Engineering Works, Houston, Tex., has been incorporated with a capital of $32,000 by J. R. Giddens, R. R. Chamberlain and E. B. Davis.

The New York Canal and Great Lakes Corporation, Wilmington, Del., has been incorporated with a capital of $5,000,000 to own and operate boats.

The Palm Beach Steamship Line, West Palm Beach, Fla., has been organized with a capital of $75,000 to establish a steamship line from West Palm Beach to Jacksonville, Fla.

The Steamship Service Corporation, Dover, Del., has been incorporated with a capital of $100,000 to own and operate boats.

FOREIGN ACTIVITIES

Moreton Bay—The twin-screw geared turbine passenger and cargo ship Moreton Bay, built to the order of the Commonwealth Government Line of Steamers, was launched recently from the yards of Vickers Naval Construction Works, Barrow. Her length is 548 feet 9 inches, breadth molded 68 feet, depth molded 43 feet 6 inches, and her displacement is 23,120 tons. She was classed 100A-1 by Lloyd's and built to the requirements of the British Board of Trade, for passenger ships, and in addition complies with the Australian Navigation Act. The complete turbine installation is capable of developing a collective shaft horsepower of 9,000 with the revolution of the propeller shafts about 90 per minute. The main machinery consists of two sets of steam turbines of the reaction type. She has a speed of 15 knots.

Gouverneur General Chanzy—The twin-screw geared turbine steamer Gouverneur General Chanzy was launched on May 9th from the Birkenhead shipyard of Messrs. Cammell, Laird & Company, Ltd. She was built to the order of Le Commission aux Transport Maritime et a la Marine Marchande for the mail, passenger, and cargo service between Marseilles and Algiers. Her dimensions are: 377.6 feet by 53.1 feet by 29.33 feet, to carry 162 first class passengers, 84 second class and 56 third class passengers. The vessel has two sets of Parsons compound double reduction geared steam turbines.

Absina—The firm of Swan, Hunter & Wigham Richardson, Ltd., England, recently launched the twin-screw steamer Absina, which was built to the order of La Societe Generale de Transports Maritimes a Vapeur. She has a length of 470 feet, breadth 58 feet and a depth of 34 feet 3 inches. She will be capable of accommodating 94 first class passengers, 80 second class and 48 economic second class passengers. She is equipped with double reduction geared turbines of the Metropolitan Vickers Rateau type, constructed by the builders to burn coal or oil fuel under Howden's system of forced draught.

Eromauga—The Commonwealth Government steamer Eromauga was recently launched from the Walsh Island Dockyard. The vessel is of the Isherwood type, shelter-decked, with the bridge and poop decks extending the full length of the ship. She is built to conform in all respects to the provisions of the Navigation Act. She is 331 feet long, with a breadth of 47 feet 9 inches and a depth of 33 feet 7¾ inches. She is designed to carry a cargo of 6,000 tons and at full load has a displacement of 9,000 tons. She will be electrically lighted throughout. Power will be provided by steam generated in three watertube boilers of the Babcock & Wilcox type.

Steigerwald—The steamer Steigerwald, built for the Hamburg-American Line, was recently successfully launched from the yards of the Deutsche Werft, Germany. She is to replace a vessel of the same name which was lost during the war.

Flora—The Scheepswerf "Het Huis de Merwede" of Papendrecht have launched the steamer Flora, built for the Kon. Ned. Stoomboot Mij. of Amsterdam. She is a shelter-deck cargo steamer of 2,200 tons deadweight built to the highest class of the Bureau Veritas. She is 260 feet in length, beam molded, 39 feet, and a molded depth of 18 feet. The vessel will be equipped with triple expansion engines of 1,000 indicated horsepower, with cylinders 20 inches by 31 inches by 50 inches, with 36-inch stroke.

Dry Dock, Manila, P. I.—It is reported that a dry dock with a capacity for vessels up to 8,000 tons is to be constructed at Manila.

Shipyard Purchase, Scotstown, Scotland—It is officially announced that Sir Edward Mackay Edgar, Bt., of Messrs. Sperling & Company, is the purchaser of the Blythswood Shipbuilding Company, Scotstown. He is also a director of the Northumberland Shipbuilding Company, Ltd., William Doxford & Sons, Ltd., the Fairfield Shipbuilding & Engineering Company, Ltd., Workman, Clark & Company, Ltd., and the Monmouth Shipbuilding Company, Ltd.

Steam Trawlers, Nantes, France—The Societe Nouvelle des Pecheries a Vapeur of Arcachon has placed a contract with the Ateliers et Chantiers de Bretagne for two steam trawlers 184 feet in length, 29 feet beam and 16 feet in depth. These vessels are being built under the survey of the Bureau Veritas.

Naval Yard to Open, Nantes, France—It is reported that the new naval yards of Coueron are to be opened, and it is hoped that within a very short time the keel of the first cargo steamer to be built at this yard will be laid down. The vessel will be of the 4,500-ton Rhuys type.

Barges, France—The Forges et Chantiers de la Mediterranee have under construction three steel steam barges of the Vulcain type for the French Mercantile Marine Commission. The vessels will have a length overall of 148 feet 5 inches, beam 26 feet 4 inches and a depth to bridge of 13 feet 2 inches. The barges will be equipped with triple expansion engines having 480 indicated horsepower and will have a speed of 11 knots. Steel derricks, each capable of lifting 15 tons and operated by steam winches, will be placed on these barges.

To Improve Port of Marseilles, France—It is reported that Versailles port is to be further improved by the installation of new quays on the north bank of the Etang de Caronte. These are to be erected by a French combine including Fougerolle Freres and the Societe Marseillaise de Traffic Maritime. Port de Bouc improvements will also be undertaken and concern changes in the entrance channel and the dock, the filling up of the coves of Gaffette de Campeau and of Labillon, the broadening of the Marseilles-Rhone Canal along a stretch of 800 yards on the right of the Anse de Gaffette and the excavation of a new maneuvering dock on the south bank of the canal. Half the expense of these improvements will be borne by the Government. The huge floating dock to be built is estimated to cost about 123,000,000 francs.

Floating Docks, Dunkirk, France—An entirely new outer port is to be constructed here, according to the French Ministry of Public Works. Two floating docks are to be provided and there will be connection by canal with the naval repair yard on the As River.

Ferryboats, Docks, Etc., Havre, France—The French Ministry of Public Works is reported to have been authorized to proceed with the extension of the port of Havre. New docks will be constructed, an existing dock deepened and the quays enlarged, which should add some 12,000 feet to the existing wharves. The canal system is to be extended and the canal from Havre to Tancarville is to be widened and deepened. Communication between Havre and Rouen is to be improved, new ferryboats will be built, as well as additional warehouses to accommodate an increased quantity of goods.

Bill to Encourage Shipbuilding, Spain—A bill for the encouragement of Spanish shipbuilding introduced by the Minister of Commerce and Public Works provides that flag and import duties will be levied on all vessels built abroad, and customs duties on materials and fittings necessary for shipbuilding will be reduced. This reduction will be based on the condition of each of the national industries affected. In addition, during a period of ten years a bounty on a tonnage basis will be granted on vessels constructed during that period in Spanish yards or laid down six months before the expiration of the period. A bounty will also be granted to Spanish built vessels carrying a fixed quantity of Spanish products or material necessary for the national industries. The bill prohibits the sale abroad or the employment on non-national service of any vessel benefiting under the proposed scheme.

Hamburg-American Line Building Program, Germany—Plans have been made for the reconstruction of about one-third of the Hamburg-American Line's prewar fleet in the course of the next five years. This new fleet will consist largely of freight ships of from 5,000 to 12,000 tons deadweight. Some of the largest and fastest of these freight ships, which are suitable for the North Atlantic and the South American trade, will be equipped with a limited number of rooms for cabin passengers and a moderate capacity for third class passengers. Two large vessels of 22,000 tons gross have been ordered for the North Atlantic trade to carry first, second and third class passengers and a fair amount of cargo, and are expected to be ready about the spring of 1924. They will have a speed of about 16 knots. Most of the freighters will be equipped to burn either coal or oil fuel, and some will have reciprocating engines and some Diesel engines.

Shipbuilding Report, Germany—The report for 1920 of the Vulcan Werke of Hamburg and Stettin shows a gross profit of 12,617,783 marks, as compared with 6,318,951 marks for the previous year. The directors announce that the results for the year have been influenced favorably by the extensive and brisk dock and repair activities in both Hamburg and Stettin. Progress with new construction, however, is still slow and difficulty is experienced in obtaining contracts owing to the unfavorable impression created by labor unrest in the company's establishments.

New Tank Steamer, Japan—The steamer Tsurmi, a vessel of 8,000 tons capacity, is being constructed by the Osaka Iron Works for service in the oil carrying trade.

New Ferry Floats, Japan—The Japanese railway department has placed an order for two more railway car ferry floats with the Osaka Iron Works for the Shimonoseki-Moji service. These floats will cost 450,000 y.

New Dock for Shipyard, China—The Kiangnan Shipbuilding Yard, Shanghai, will build a new dock 500 feet long to the west of the arsenal.

To Improve Harbor, Japan—Y. 3,000,000 will be spent for reclamations in Sakai Harbor near Osaka.

Government Ships, Roumania—It is announced from Roumania, according to information received from Dr. Ing. Waldimir V. Mendl, naval architect of Braila, that the gunboat Mignonne has been bought from the French Government. The destroyers Sparviero and Nibbio, together with the Aquila and Falco which had been ordered for the Roumanian Navy before the war, were taken over by the Italians at the beginning of hostilities. Two of these boats have now been restituted. The other craft are former Austrian vessels allowed Roumania by the Conference of Ambassadors. Several monitors are already in Roumania after having been in Servian hands since the armistice and depleted of all valuable parts, necessitating very extensive repairs. Seven torpedo boats are in Venetia and have been taken over by Roumania and are being repaired by the Italian Navy Arsenal of this town. Two of them are already completed.

In the announcement of the new names for various ships of the Roumanian Navy, three monitors are named after new provinces, three torpedo boats are named after the various winds, four torpedo boats are named after former Roumanian warships, two destroyers are named after battles of the world war, and four gunboats are named after fallen officers.

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BUSINESS NOTES

Edward A Knowles, C. E. E. E., consulting engineer and fuel expert, has become associated with Murrie & Co., Inc., engineers, at 74 Broadway, New York, and is in charge of pulverized coal and gas fuel engineering work.

The C. H. Wheeler Manufacturing Company, of Philadelphia, Pa., manufacturers of condensers, pumps, etc., has opened a new branch office in Boston, Mass., located at 53 State street, Room 613.

It is announced that the autumn meeting of the Lyons Fair will be held from October 1 to October 15, next, in Lyons, France. The fair is believed to constitute an important manifestation for the promotion of international trade in the world. American manufacturers may receive information on application to Emile Garden at the New York office of the fair, 150 Nassau street.

Willard C. Brinton, president of the Terminal Engineering Company, Inc., manufacturers of the TEC truck, and varied material-handling machinery, announced that J. F. McGonigal, mechanical engineer, formerly of the Foamite Company, and J. H. Potter, machanical engineer, a graduate of New York University, have joined the organization. M. E. Lyle, for many years with the Columbia Graphophone Company, has been elected vice-president, and M. E. Peck has been elected secretary and assistant treasurer.

It is announced by the Page Steel & Wire Company that W. H. Bleecker, Jr., formerly district sales manager of the Chicago office will be transferred to the New York office, in the Grand Central Terminal, in the same capacity, and E. J. Flood has been appointed district sales manager for the Page products in the Chicago office, at 208 South LaSalle street, succeeding Mr. Bleecker.

It is announced that the New York office of the Canton Foundry & Machine Company, Canton, Ohio, has been established in new headquarters at 45 West 18th street. The company's sales exhibit office was formerly at the Grand Central Palace and is under the management of H. B. Bergere and L. Wechsler. The company's complete machinery line, comprising Canton portable cranes, Canton alligator shears, turn tables, etc., is now on display in the new quarters.

TRADE PUBLICATIONS

Steam Turbines for Mechanical Drive.—The application of the Curtis steam turbine for driving circulating and boiler feed pumps, as well as centrifugal pumps for all purposes, fans and blowers are described in detail in a bulletin recently issued by the General Electric Company, Schenectady, N. Y. The principles involved in the design of this turbine are summarized, including the wheel, shaft and buckets, casing, bearings, packing, governor, and other elements. This turbine may be used with slight changes for condensing or non-condensing operation, and may also be adapted to steam pressures ranging from 60 to 250 pounds.

Life Saving Equipment.—The steamship *Governor* which sank in eighteen minutes on the night of April 2, 1921, was equipped with modern life saving equipment which enabled all of the passengers and crew to leave the vessel without accident. The story of the disaster and the part Steward mechanical boat davits and deadrise metallic lifeboats played in the rescue work is told in an illustrated bulletin prepared by the Steward Davit and Equipment Corporation, New York.

Electric Drill Stands.—The Thor electric drill stand recently developed by the Independent Pneumatic Tool Company, Chicago, Ill., is intended for use with a wide range of drill sizes of the portable type, adapting them to work formerly done on drill presses. The details of the construction and methods of adjustment are given in a pamphlet sent out by this company.

Oxy-Acetylene Apparatus.—A review of the various forms of welding equipment produced by the Davis-Bournonville Company, Jersey City, N. J., is given in their latest descriptive bulletin. Acetylene generators, welding and cutting torches, pressure regulators and portable outfits are taken up in detail.

Steam Tables for Condenser Work.—The sixth edition of this work dealing with the condensation and evaporation of steam has just been sent out by the Wheeler Condenser and Engineering Company, Carteret, N. J. This book explains how measurements are made by means of the mercury column and barometer, and gives tables of constants and corrections for the thermal expansion of mercury and the brass scale, which allows the ready calculation of vacuums in inches of mercury. The values were specially calculated for the book by Professor Lionel S. Marks.

Receiver Type Separators.—The Griscom Russell Company, New York, has issued Bulletin 1140 containing a description of the Stratton steam separator, designed to remove water from the steam by the use of centrifugal force. Tabular specifications are given for each type separator and diagrams and photographs of typical installations.

The Strong Arm of Industry.—Examples of approved applications of electric hoists in practically every manufacturing industry are illustrated and described in a bulletin sent out by the Electric Hoist Manufacturing Association, New York.

Ventilators.—Application of the siphonage principle of ventilating buildings as accomplished by K-S-V ventilators is demonstrated in a catalogue issued by the Kernchen Company, Chicago, Ill. Illustrations and descriptions of typical installations are included in the book together with complete diagrams and specifications of the device.

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President—Capt. A. J. Hepburn, U. S. N.
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NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
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1701 Walnut Street, Philadelphia, Pa.
Secretary—C. S. King.

AMERICAN STEAMSHIP OWNERS' ASSOCIATION
17 Battery Place, New York
Vice-President and General Manager—Winthrop L. Marvin.

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17 Battery Place, New York

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INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

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